N00174.AR.001024
NSWC INDIAN HEAD
5090.3a

CHARACTERIZATION REPORT FOR CLOSURE OF SAFETY THERMAL TREATMENT POINT NSWC INDIAN HEAD MD

10/3/1995

VERSAR INC.

CHARACTERIZATION REPORT

for Closure of the Safety Thermal Treatment Point at Indian Head Division, Naval Surface Warfare Center, Indian Head, Maryland

Submitted to:

Shawn Jorgensen, Code 0965C
Naval Surface Warfare Center
Indian Head Division
20 Strauss Ave.
Indian Head, Maryland 20640-5035

Submitted by:

Versar Inc.
6850 Versar Center
Springfield, Virginia 22151

Under Contract No.:
N62477-91-D-3576(A/E)

October 3, 1995

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 SUMMARY OF STUDY AND CONCLUSIONS

1.1 Purpose of Study

A study was undertaken to characterize and determine whether clean closure of the Safety Thermal Treatment Point (STTP) was feasible under Subpart X of the Resource Conservation and Recovery Act (RCRA). The STTP was used for thermal treatment of explosives and propellants resulting from research and/or testing operations and open burning of most of the explosive and propellant scrap waste produced at the Indian Head Division, Naval Surface Warfare Center (IHDIV-NSWC). It has been inactive since December 1988. Sampling of soil and ground water was conducted to characterize the area in 1993 as part of the closure study. The sampling scheme was designed so that sufficient data would be collected to evaluate the potential for clean closure of the STTP. For the purposes of this study, clean was defined as no analytes detected above background values and all analyses being within the method-specified QA/QC limits.

1.2 Summary of Findings and Recommendations

As described in the summary of results (Section 2.0), contamination (primarily metals and explosives) was identified at the STTP. Although most contaminant concentrations were not significant, several were higher than regulatory or risk-based screening levels and/or background levels. As a result, the U.S. Navy, IHDIV-NSWC, cannot expect to clean close this site without further corrective action.

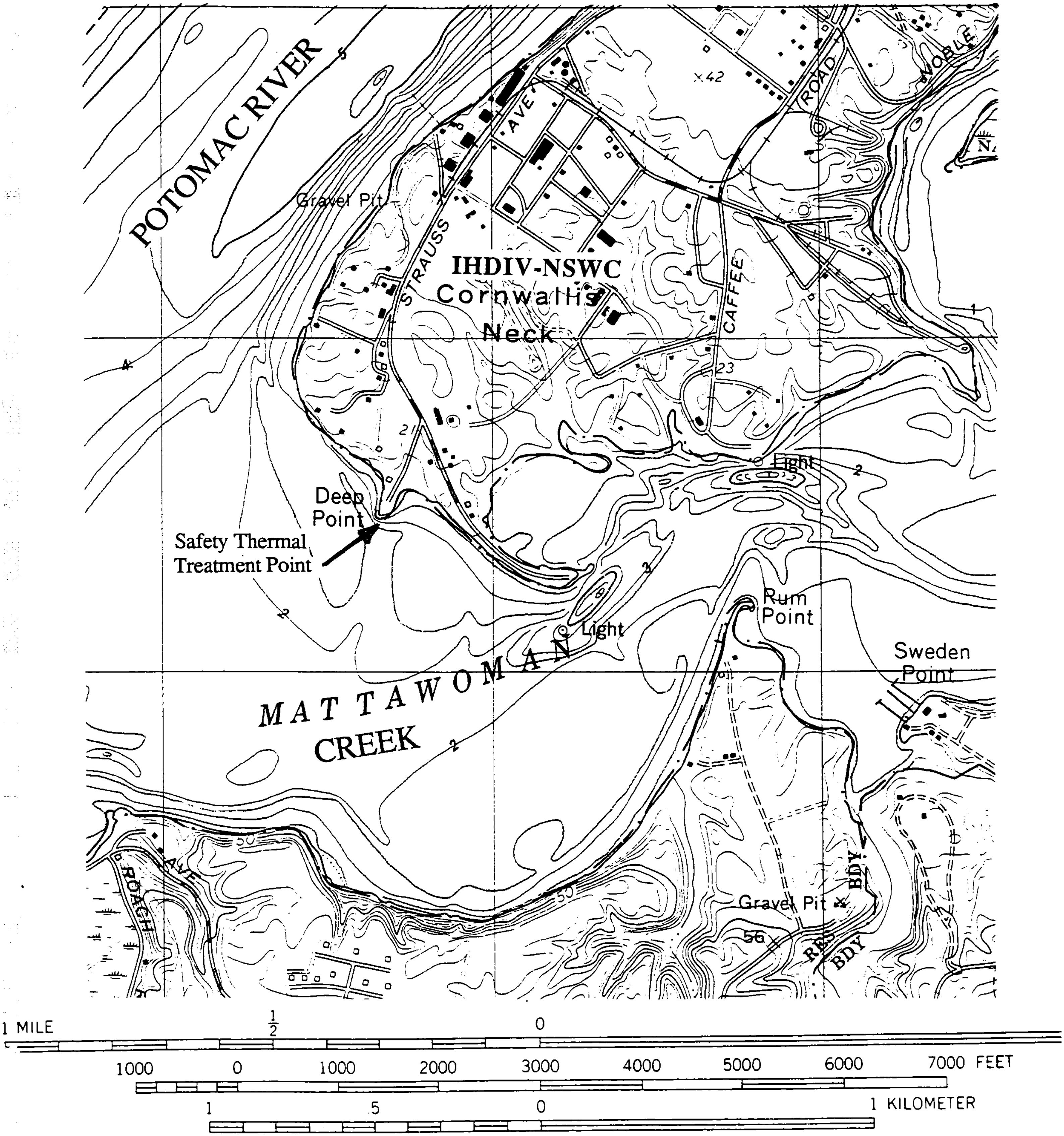
A RCRA closure plan must be prepared to describe the approach for closure of the STTP. This plan will include the following information: methods for removing or treating the contaminated soil, criteria for determining the closure action required to satisfy the closure performance standard, and additional monitoring required during closure and post-closure. It is expected that the following actions will be taken: removal of structures (i.e., shield and treatment unit) and removal of contaminated soil. Issues associated with the local wetland environment may necessitate additional measures, such as wetland restoration and permitting requirements. A permit must be obtained from the U.S. Army Corps of Engineers for cleanup activities occurring in wetlands, as identified by delineation. This permit applies to activities required to effect the containment, stabilization, or removal of hazardous or toxic waste materials performed, ordered, or sponsored by a government agency.

1.3 Site Description

The STTP is located on a small peninsula at the confluence of Mattawoman Creek and the Potomac River and encompasses the area from the tip of the peninsula back 300 feet toward the mainland. A topographic map of the area surrounding the STTP is provided in Figure 1.

The STTP consists of two areas, a primary burn area and a secondary burn area. The primary burn area includes the first 150 feet from the tip of the point and the secondary area stretches 150 feet from the primary burn area to the end of the STTP (300 feet from the tip of the point). A topographic map of the STTP is shown in Figure 2. There is no record that the secondary burn area was used for open burning (OB).

The treatment unit itself is a cylindrical steel unit located in the primary burn area. The unit is approximately 8 to 10 feet high and approximately 10 feet in diameter. The primary purpose of the unit is to minimize fugitive emissions of ash and debris. A 15-by-15 foot steel shield is also located in the primary area. The shield is designed to prevent material ejected from the treatment unit from reaching the surrounding water. Miscellaneous explosives testing equipment is located in the secondary area. Since these pieces of equipment are only used for testing of explosives (e.g., deflagration-to-detonation testing, pierce testing, etc.) and not for waste treatment, they are not classified as RCRA units.

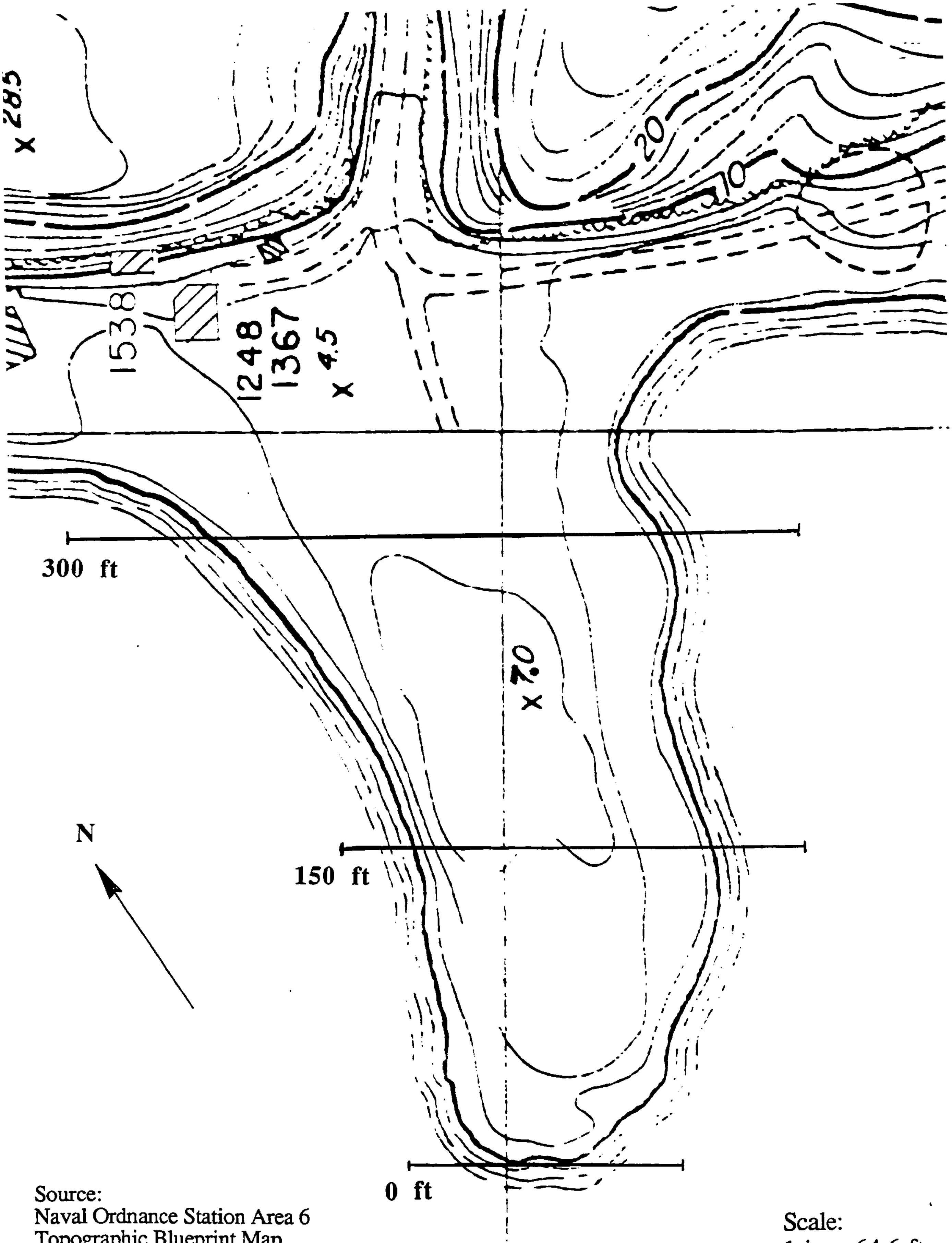


CONTOUR INTERVAL 10 FEET
BATHYMETRIC CONTOUR INTERVAL 1 METER

N

Source:
USGS 7.5 minute series (enlarged 155%)
Indian Head, MD-VA quadrangle
Photorevised 1978

Figure 1 Topographic Map of Surrounding Area



Source:
Naval Ordnance Station Area 6
Topographic Blueprint Map
Navy Area Public Works Office
Drawing Number 43050

Scale:
1 in = 64.6 ft
1.55 in = 100 ft

Figure 2 Topographic Map of STTP

1.4 Site Sampling

Soil and ground-water sampling were conducted as part of the STTP characterization effort. Soil samples were collected on January 20, 1993, and ground-water samples were collected on March 29, 1993.

There were eight soil sample locations, plus a field duplicate (Sample Location 9) and a background sample (Sample Location 10). The soil sample locations are numbered 1 through 10 on Figure 3. These sample points are located on a 50-foot grid centered on the location of the treatment unit. Soil samples were collected from the selected area using a stainless steel hand auger and sampling scoop. The samples were collected from the top 18 inches of the surface soil. Soils analyzed for volatile organics were taken from a depth of 6 to 12 inches and placed directly into sample jars. Soils analyzed for other parameters were mixed thoroughly in stainless steel bowls prior to filling the sample jars.

The duplicate analysis (Sample 9) was conducted on soil from sample location 3, and the matrix spike/matrix spike duplicate (MS/MSD) were collected from sample location number 6.

There were three ground-water sampling locations, plus a field duplicate and a background sample. The water sample locations are numbered W1, W2, and W3 on Figure 3. Location W1 is centered on the location of the treatment unit. Locations W2 and W3 are located a distance of 50 feet farther from the point and 50 feet to the left and right of location W1. The water samples were collected using temporary sand point wells.

The duplicate analysis was performed on samples from location W1. The MS/MSD were conducted on samples from location W3.

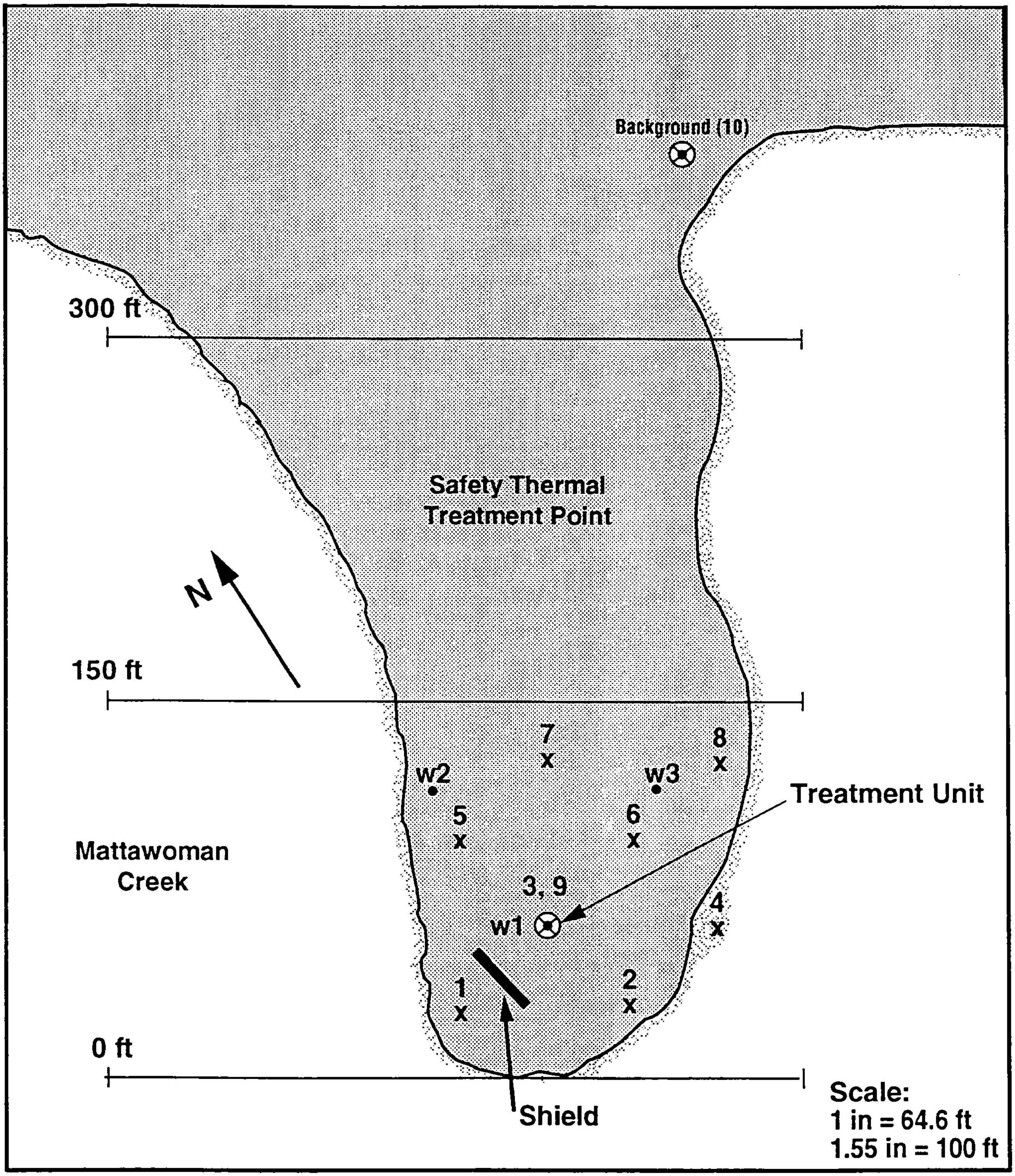


Figure 3 Location of Sampling Points

The background sampling location is approximately 340 feet northeast of the treatment unit, as shown in Figure 3. Additional information on the site and the sampling procedures used is contained in the Sampling and Analysis Plan (Ref. 1).

1.5 Report Organization

This report presents the characterization results for the site, for both soil and groundwater sampling. Comparison of the detected concentrations of contaminants to regulatory limits and guidance are also provided. Section 2.0 provides a summary of the results, and Section 3.0 provides a summary of the QA/QC results. Section 4.0 provides a detailed description of the analytical results. Appendix A contains tables of analytical results, and Appendix B includes additional description of the QA/QC results (including tables of QA/QC results).

2.0 SUMMARY OF RESULTS

Table 2-1 summarizes the parameters analyzed and the methods used. Method references are provided in Table 5 of the Sampling and Analysis Plan. The corresponding analytical results, as indicated in Table 2-1 below, are provided in Appendix A. A summary of the results is presented in this section (Section 2.0), and a detailed description of the results is provided in Section 4.0.

Table 2-1. Analytical Parameters and Methods

Analytes	Analytical Methods	Location of Detailed Analytical Results
Explosives	USATHAMA - HPLC	Table A-1, Table A-7
VOCs	SW-846, Method 8240	Table A-2, Table A-8
SVOCs	SW-846, Method 8270	Table A-3, Table A-9
Total Metals	SW-846, Method 6010 or AA	Table A-4, Table A-10
TCLP Metals	SW-846, Method 1311 and 6010 or AA	Table A-5
Sulfide	MSA/MCAWW 335.2	Table A-6, Table A-11
Cyanide	CLP 335.2	Table A-6, Table A-11
Nitrate-Nitrite	MSA/MCAWW 353.2	Table A-6, Table A-11

2.1 Soil Sample Results

Analytical results for soil samples with contaminant concentrations greater than those found in the background sample are presented in Table 2-2. The highest concentrations of metals were found near the treatment unit. The distribution of analytes other than metals (i.e., explosives, volatiles, semivolatiles, and general chemistry parameters) seems to be random. Each type of explosive was found in only a few samples, so no trend is apparent in terms of sample location, concentrations, or type of explosive detected.

Table 2-2
Indian Head - Safety Thermal Treatment Plant
Soils Sampling
Contaminants Present at Levels Greater Than Background Sample (mg/kg)

Analyte	Sample Number									
	1	2	3	9 (Field Dupl. for Sample 3)	4	5	6	7	8	10 (Background Sample)
Aluminum	8,060	9,220	11,100	10,400	--	--	6,740	5,100	3,960	2,950
Antimony	--	5.0	4.0	4.3	--	--	3.0	--	--	ND (2.7)
Arsenic	16.5	--	--	9.2	--	--	--	--	--	6.9
Barium	--	382	1,550	963	--	--	67.5	84.9	--	53.9
Beryllium	--	--	0.35	0.30	--	--	0.33	--	--	0.28
Cadmium	1.9	14.8	6.6	5.8	--	--	0.84	--	--	0.46
Calcium	--	986	2,010	1,220	--	--	--	--	--	943
Chromium	14.9	44.6	101	76.8	--	--	48.1	21.8	9.7	9.5
Cobalt	--	8.2	14.2	13.6	--	--	9.5	17.4	--	4.3
Copper	29.5	362	133	137	--	--	44.0	--	--	26.8
Iron	14,400	14,000	27,300	24,500	--	--	19,300	16,100	10,400	9,330
Lead	--	188	287	382	--	--	1,010	522	280	106
Magnesium	--	749	1,150	934	--	--	--	--	--	532
Manganese	--	298	198	174	--	--	--	485	--	138
Mercury	--	1.6	--	--	--	--	3.8	0.54	4.4	0.24
Nickel	13.6	38.5	55.5	42.8	--	--	70.4	--	--	6.4
Potassium	675	604	976	836	--	--	488	495	--	390
Selenium	0.29	--	--	--	--	--	--	--	--	0.25
Sodium	--	63.5	1,040	575	--	--	--	--	--	56.9
Vanadium	27.8	22.1	28.5	26.4	--	--	22.5	19.4	--	15.6
Zinc	--	238	96.7	150	--	--	97.9	178	81.8	79.4
Tin	--	8.5[a]	12.8[a]	9.8[a]	6.1[a]	5.6[a]	11.3[a]	--	6.0[a]	4.0[a]

Table 2-2
Indian Head - Safety Thermal
Treatment Plant Soils Sampling
Contaminants Present at Levels Greater Than In Background Sample (mg/kg)
(Continued)

Analyte	Sample Number									
	1	2	3	9 (Field Dupl. for Sample 3)	4	5	6	7	8	10 (Background Sample)
HMX	13/9.8[c]	--	--	--	--	--	--	--	4.3/3.6[c]	ND (0.50)
RDX	--	0.69	--	--	--	--	--	--	--	ND (0.59)
DNB	--	--	--	--	--	--	--	4.8	--	ND (0.42)
DNT[b]	--	--	--	--	--	--	--	6.0	--	ND (0.82)
NG	--	--	--	--	--	--	180	--	1.6	ND (1.0)
Acetone	--	--	--	0.014	--	0.008[e] (0.011)	--	--	--	ND (0.011)
2,4-Dinitro-toluene[d]	--	--	1.8	0.24[e] (0.41)	--	--	--	--	--	ND (0.39)
Bis(2-ethyl-hexyl)phthalate	--	--	0.4[e] (0.41)	--	--	--	--	--	--	ND (0.39)
5-Nitro-o-toluidine	--	--	0.41	--	--	--	--	--	--	ND (0.39)
Cyanide	--	--	2.28	1.19	--	--	2.82	0.761	--	ND (0.597)
Nitrate	--	--	--	--	--	--	6.72	5.31	--	2.84

NOTES:

Sample locations are shown on Figure 1.
-- Indicates that the analyte was not present at a concentration greater than that found in the background sample.
ND = Not detected at the detection limit in parenthesis.

[a] This analyte was found at 7.6 mg/kg in the laboratory blank, so the concentrations detected in the rest of the samples may be attributed to laboratory contamination.
[b] Combination of 2,4- and 2,6-DNT, analyzed by HPLC.
[c] Only confirmed identifications of HMX are reported; the result from the primary column is shown first, followed by the result from the confirmation column.
[d] 2,4-DNB as determined by GC/MS.
[e] Detected at a concentration below the detection limit shown in parentheses.

1128\tables\saftherm.tbl

2.1.1 Total Metals

All but three of the metal analytes (antimony, silver, and thallium) were detected in the soil background sample. The following metals were detected at one or more sample locations at a concentration greater than five times the background: barium, cadmium, chromium, copper, lead, mercury, nickel, and sodium.

Sample locations 2, 3, 9 (field duplicate of 3), and 6 have the highest concentrations of metals relative to the concentration in the background sample. Barium, chromium, and sodium concentrations are highest at location 3 (at the treatment unit); lead, mercury, and nickel concentrations are highest at location 6, east of the treatment unit; and cadmium and copper concentrations are highest at location 2, south of the treatment unit. Soil sample locations 4 and 5 appear to have the least contamination, with no analytes found at levels above the background concentration.

2.1.2 TCLP Metals

As shown in Table A-5, only one analyte for one sample location exceeded the TCLP regulatory limits. Sample 7 had a lead concentration (in the leachate) of 10.4 mg/L, with the regulatory limit set at 5 mg/L.

2.1.3 Explosives

Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX) and nitroglycerine (NG) were the explosives found most frequently in soil samples, with each identified in two of the ten samples. The highest concentration was for nitroglycerine, in Sample 6, at 180 mg/kg.

2.1.4 VOCs

Only very small quantities of volatile organic compounds (VOCs) were found in the soil samples, and only acetone, at 0.014 mg/kg, was found at a level above (but very close to) the detection limit in the field duplicate, Sample 9.

2.1.5 SVOCs

Three of the semivolatile organic compounds (SVOCs), diethylphthalate, 2,4-dinitrotoluene (2,4-DNT), and 5-nitro-o-toluidine, were found in the soil samples at concentrations above the detection limit. 2,4-DNT and 5-nitro-o-toluidine were found at 1.8 mg/kg and 0.41 mg/kg, respectively, in Sample 3. Diethylphthalate was found in Sample 6 at 0.52 mg/kg. Only one concentration was more than 10 percent above the background level; in Sample 3, the 2,4-DNT concentration was more than four times the background value.

2.1.6 General Chemistry

Cyanide was found in four of ten samples, with the highest concentration at 2.82 mg/kg in Sample 6. All of the detected concentrations for cyanide were higher than the background. Nitrate was found in all of the samples, with concentrations ranging from 0.259 mg/kg in Sample 4 to 6.72 mg/kg in Sample 6. However, only the concentrations in Samples 6 and 7 were higher than the background. No sulfide was detected in any of the samples, with detection limits for sulfide near 50 mg/kg.

2.2 Ground-Water Results

Analytical results for ground-water samples with contaminant concentrations greater than those found in the background sample are presented in Table 2-3. Location W1, the area nearest

Table 2-3
Indian Head - Safety Thermal Treatment Plant
Ground-water Sampling
Contaminants Present At Levels Greater Than In Background Sample (μg/L)

Analyte	Sample				
	W1	W2	W3	W3 Duplicate (Field Duplicate)	Background
Aluminum	29,800	–	8,590	–	7,710
Arsenic	34.6	–	35.9	24.5	15.9
Barium	1,100	–	369	296	58.8
Beryllium	1.9	–	–	–	ND (1.0)
Cadmium	5.4	–	–	–	ND (4.0)
Calcium	13,800	20,400	74,300	64,200	5,630
Chromium	70.3	30.2	36.2	20.8	14.3
Cobalt	24.6	–	10.2	4.5	3.6
Copper	586	–	68.1	30.6	29.7
Iron	63,900	–	15,200	–	9,250
Lead	5,110	–	316	200	28.8
Magnesium	6,610	4,210	15,100	14,200	2,590
Manganese	825	338	224	166	77.7
Mercury	22	–	–	–	ND (0.2)
Nickel	87.1	27.7	15.4	18.7	ND (13)
Potassium	6,840	2,370	7,850	7,010	1,080
Selenium	2.3	–	–	–	1.5
Silver	10.6	–	–	–	ND (4.0)
Sodium	66,600	–	–	–	37,600
Vanadium	99.2	–	23.7	–	20.7
Zinc	2,500	–	255	155	83.2
HMX	–	–	1,100	1,100	ND (640)
TNT	840	–	–	–	ND (340)
Pyridine	–	–	33	79	ND (22)
1,2-Dichloroethene	–	–	8	7	ND (5)
Cyanide	212	–	10.6	–	ND (10)
Nitrate	–	1,170	–	–	330

NOTES:

Sample locations are shown on Figure 1.
– Indicates that the analyte was not present at a concentration greater than that found in the background sample.
ND = Not detected at the detection limit in parenthesis.
All results μg/L or parts per billion (ppb).

1128\tables\safther.tb2

the treatment unit, has the highest concentration of inorganic contaminants in ground water. Location W2 had the lowest contaminant concentrations. There were few explosives and organics detected so it is not possible to fully define the extent of contamination for those parameters.

2.2.1 Metals

Location W1, at the treatment unit, had the highest concentration of toxic metals (lead, mercury, zinc, beryllium, and cadmium), as well as cyanide and other inorganic constituents. The W3 sample and its duplicate had concentrations of barium, lead, manganese, and zinc greater than five times above background levels. Location W2 had no analytes measured at greater than five times the background. The high concentrations of inorganic cations, such as calcium, magnesium, potassium, and sodium found in all the ground-water samples are most likely caused by the brackish nature of the adjacent Mattawoman Creek.

2.2.2 Explosives

Only two explosives were found in the ground water-samples, HMX in the W3 sample and its field duplicate, at 1.1 mg/L, and trinitrotoluene (TNT) in the W1 sample at a concentration of 0.84 mg/L.

2.2.3 VOCs

For VOCs, only 1,2-dichloroethene was detected at a level greater than the background (detection limit), with the highest concentration being 8 μg/L in the W3 sample.

2.2.4 SVOCs

For SVOCs, only pyridine was detected at a concentration greater than the background (detection limit). It was found in the W3 and field duplicate samples, at concentrations of 33 μg/L and 79 μg/L, respectively.

2.2.5 General Chemistry

Cyanide was detected in the W1 sample at 220 μg/L, a concentration greater than five times the background (detection limit). Nitrate was found in the W2 sample at 1,170 μg/L, a concentration greater than three times the background. Sulfide was not found in any of the ground-water samples.

2.3 Comparison of Results Against Regulatory and Screening Levels

Contaminant concentrations found in the soil and ground-water samples were evaluated against various regulatory and screening limits as shown in Table 2-4. Typically, the screening levels presented are used as guidance by regulatory personnel and are not enforceable limits. At lease one analyte in each sample exceeded a regulatory or screening limit. Those values exceeding the limits are shown in boldface type. The regulatory and screening limits are shown in Table 2-5. All applicable limits are shown, but only those exceeded by the results/concentrations in Table 2-4 are highlighted in boldface type. Table 2-6 presents a similar comparison for ground-water samples, but both the sample results and the applicable limits are shown in the same table.

The soil results were compared to the Proposed RCRA Corrective Action Levels (Ref. 2), the Region III Risk-Based Screening Levels (RBSLs) (Ref. 3), and the Draft OSWER Soil Screening Guidance (residential) (Ref. 4), as applicable for each chemical. For metals and other

Table 2-4
Indian Head - Safety Thermal Treatment Plant
Soils Sampling
Contaminant Concentrations As Compared To Screening Levels (mg/kg)

Analyte	Sample Number									
	1	2	3	9 (Field Dupl. for Sample 3)	4	5	6	7	8	10 (Background Sample)
Arsenic	**16.5**[a,b,c,d]	**2.9**[a,b,c,d]	**6.9**[a,b,c,d]	**9.2**[a,b,c,d]	**0.70**[a,c]	**0.79**[a,c]	**5.1**[a,b,c,d]	**6.8**[a,b,c,d]	**2.8**[a,b,c,d]	**6.9**[a,b,c,d]
Barium	**53.3**[f]	**382**[f]	**1,550**[e,f,g]	**963**[e,f]	**11.2**[f]	**6.2**[f]	**67.5**[f]	**84.9**[f]	**31.3**[f]	**53.9**[f]
Beryllium	**0.27**[h,i,j]	**0.26**[h,i,j]	**0.35**[h,i,j]	**0.30**[h,i,j]	ND (0.10)	ND (0.10)	**0.33**[h,i,j]	**0.20**[h,i,j]	**0.22**[h,i,j]	**0.28**[h,i,j]
Cadmium	**1.9**[l]	**14.8**[k,l]	**6.6**[k,l]	**5.8**[k,l]	0.32	ND (0.31)	**0.84**[l]	0.31	0.38	0.46
Chromium	**14.9**[n]	**44.6**[m,n]	**101**[m,n]	**76.8**[m,n]	**4.5**[n]	1.9	**48.1**[m,n]	**21.8**[n]	**9.7**[n]	**9.5**[n]
Lead	**48.8**[o,p]	**188**[o,p]	**287**[o,p]	**382**[o,p,r]	**6.9**[o,p]	**4.1**[o,p]	**1,010**[o,p,q,r]	**522**[o,p,q,r]	**280**[o,p]	**106**[o,p]
Manganese	**75.9**[s]	**298**[s]	**198**[s]	**174**[s]	**116**[s]	**86.7**[s]	**131**[s]	**485**[s]	**65.6**[s]	**138**[s]
Mercury	0.24	**1.6**[u]	0.13	0.16	ND (0.05)	ND (0.05)	**3.8**[t,u,v]	**0.54**[u]	**4.4**[t,u,v]	0.24
Nickel	**13.6**[w]	**38.5**[w]	**55.5**[w]	**42.8**[w]	**3.0**[w]	1.6	**70.4**[w]	**5.3**[w]	**4.7**[w]	**6.4**[w]
DNT[2]	ND (0.82)	ND (0.82)	ND (0.82)	ND (0.82)	ND (0.82)	ND (0.82)	ND (0.82)	**6.0**[x,y,z]	ND (0.82)	ND (0.82)
2,4-Dinitro-toluene[3]	ND (0.410)[4]	ND (0.49)[4]	**1.8**[aa]	**0.24**[1] **(0.41)**[aa]	--	ND (0.35)[4]	ND (0.39)[4]	--	--	ND (0.39)[4]
Benzo(a) pyrene	ND (0.41)[4]	ND (0.49)[4]	ND (0.41)[4]	ND (0.41)[4]	--	ND (0.35)[4]	ND (0.39)[4]	--	--	**0.170**[1]**(0.39)**[bb]

NOTES:

-- Indicates that the analyte was not sampled at this sample location.
Bold values indicate exceedances of regulatory or screening levels.
Footnotes a-bb correspond to limits shown in Table 2-5.
ND = Not detected at the detection limit in parenthesis.
Sample numbers 3 and 9 are field duplicates.
Sample number 10 is the background sample.
All results mg/kg or parts per million (ppm).
[1] Detected at a concentration below the detection limit shown in parentheses.
[2] DNT (mixture) analyzed by HPLC.
[3] 2,4-DNT analyzed by GC/MS.
[4] The detection limit is greater than the regulatory or screening levels.

1128\tables\saftherm.tbl

Table 2-5
Indian Head - Safety Thermal Treatment Plant
Soils Sampling
Screening Levels for Contaminants (mg/kg)

Analyte	Proposed RCRA Corrective Action Level	Region III Risk-Based Screening Levels		OSWER Draft Soil Screening Levels		Range of Background Concentrations for Eastern U.S.
		Residential	Industrial	Ingestion	Migration to GW	
Arsenic	80	23 **0.37**[a] (as carcinogen)	310 **1.6**[b] (as carcinogen)	**0.4**[c]	**1**[d]	<0.1-73
Barium	4,000 (ionic)	**550**[e]	7,200	5,500	**3**[f]	10-**1,500**[g]
Beryllium	**0.2**[h]	**0.15**[i]	0.67	**0.1**[j]	18	<1-7
Cadmium	40	**3.9**[k]	51	39	**0.6**[l]	.01-22 (Ref. 6)
Chromium	400 (VI)	**39 (VI)**[m]	510	390 (VI)	**2 (VI)**[n]	1-1,000
Lead	--	**0.00078**[o] (tetraethyl)	**0.01**[p]	**400**[q]	--	<10-**300**[r]
Manganese	--	**39**[s]	510	--	--	<2-7,000
Mercury	20 (inorganic)	2.3[t] (methyl & inorg.)	31 (methyl & inorg.)	23	**0.3**[u]	0.01-**3.4**[v]
Nickel	2,000	160 (soluble salts)	2,000 (soluble salts)	1,600	**2**[w]	<5-700
DNT (mixture)	**1.0**[x]	**0.94**[y]	**4.2**[z]	See 2,4-DNT below	See 2,4-DNT below	--
2,4-Dinitrotoluene	--	160	2,000	160	**0.02**[aa]	--
Benzo(a)pyrene	--	--	--	**0.09**[bb]	0.4	--

Footnotes a-bb correspond to Table 2-4.
Bold values indicate the regulatory or screening level was exceeded in at least one sample shown in Table 2-4.
-- Indicates no regulatory or screening limits were applicable.

1128\tables\saftherm.tbl

Table 2-6
Indian Head - Safety Thermal Treatment Plant
Ground-water Sampling
Contaminant Concentrations as Compared to Regulatory and Screening Levels (μg/L)

Analyte	Sample							
	W2	W1	W3	W3 Duplicate (Field Duplicate)	Background	MCL	Proposed RCRA Corrective Action Level	Region III Risk-Based Concentration
Antimony	ND (24)[f]	ND (24)[f]	ND (24)[f]	ND (24)[f]	ND (24)[f]	6[f]	10[f]	15[f]
Arsenic	**2.2**	**34.6**	**35.9**	**24.5**	**15.9**	50	--	**11** **0.038** (as carcinogen)
Beryllium	ND (1.0)[f]	**1.9**	ND (1.0)[f]	ND (1.0)[f]	ND (1.0)[f]	4	**0.008**[f]	**0.016**[f]
Cadmium	ND (4.0)	**5.4**	ND (4.0)	ND (4.0)	ND (4.0)	**5**	--	18
Lead	**25.6**	**5,110**	**316**	**200**	**28.8**	**15**[e]	--	**0.0037** (tetraethyl)
Manganese	**338**	**825**	**224**	166	77.7	--	--	**180**
Mercury	ND (0.2)	**22**	ND (0.2)	ND (0.2)	ND (0.2)	**2**	--	**11**
Thallium	ND (2.0)	ND (2.0)	ND (2.0)	ND (10)[f]	ND (2.0)	2[f]	3[d,f]	2.9-3.3[d,f]
TNT	ND (340)[f]	**840**	ND (340)[f]	ND (340)[f]	ND (340)[f]	--	--	**2.2**[c,f]
Cyanide	ND (10)	**212**	10.6	ND (10)	ND (10)	**200**	700	730
Pyridine	ND (21)	ND (22)	33	**79**	ND (22)	--	**40**	**37**
Bis(2-ethylhexyl)phthalate	ND (11)[f]	ND (11)[f]	**5[a,b](12)**	**5[a,b](10)**	ND (11)[f]	6[f]	3[f]	**4.8**[f]

NOTES:

-- Indicates that no regulatory or screening limits were applicable.
Bold values indicate exceedances of regulatory or screening levels. (They also indicate which regulations or screening levels have been exceeded.)
ND = Not detected at the detection limit in parenthesis.
All results μg/L or parts per billion (ppb).
[a] This analyte was detected at a concentration below the detection limit shown in parentheses.
[b] This analyte was found in the laboratory blank as well as in the sample. Thus, the presence of the analyte in the sample may be attributable to laboratory contamination.
[c] The Region III RBC is for 2,4,6-trinitrotoluene.
[d] For thallium complexes.
[e] There is no MCL for lead, but an action level of 15 μg/L has been set under the Primary Drinking Water Standards.
[f] The detection limit is greater than the regulatory or screening levels.

1128\tables\saftherm.tb2

inorganic constituents, the analytical results were also compared to typical background levels for the eastern United States (Ref. 5). The Region III RBSLs for both industrial and residential scenarios were used in the comparison. There were more exceedances for residential because the values are lower. The generic (non-site specific) SSL values for ingestion, exposure, and migration to ground-water pathways were used in the comparison. The SSL values for the ingestion pathway are very similar to the RBSLs (residential). Ground-water results were compared to Maximum Contaminant Levels (MCLs) for drinking water (Ref. 6), Proposed RCRA Corrective Action Levels, and Region III screening levels (for tap water).

As shown in Table 2-4[1], there were nine metals, one explosive, and two semivolatiles exceeding the regulatory or screening limits for soil. Barium, chromium, lead, and nickel exceeded the limits in the background sample, and in other STTP field samples had concentrations greater than five times the background. As shown in Table 2-6, six metals, one explosive, two semivolatiles, and cyanide exceeded the regulatory or screening limits for water. Only lead exceeded the limits in the background sample and had other STTP field samples greater than five times the detection limit. The analytes exceeding a limit for both soil and water were arsenic, beryllium, cadmium, lead, and manganese.

---

[1]It is important to remember that the RCRA corrective action levels have not been promulgated, that the Region III Risk-Based Concentrations (RBCs) and Draft OSWER Soil Screening Guidance (SSLs) are used as tools for preliminary site assessment and generally should not be used to set cleanup or no-action levels at CERCLA or RCRA Corrective Action sites, and that the applicability of MCLs and tap water levels to the ground water at the STTP is questionable at best. The only purpose of these comparisons is to give some indication as to the relative magnitude of contamination. In addition, given that, in most cases where there was an exceedance, the background sample also exceeded the limit, the value of these comparisons is questionable.

3.0 SUMMARY OF QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) RESULTS

Sample collection and analysis protocols were followed to ensure proper handling of samples and proper use of equipment. These procedures include sample documentation, sample tracking and storage, calibration of equipment, and preparation of laboratory blanks. The laboratory raw data indicate proper handling of samples and proper operation of equipment.

Field and laboratory QC samples are collected or prepared and analyzed to provide a basis for data quality evaluation. These samples include field and laboratory blank samples, field and laboratory duplicate samples, surrogate spike samples, and matrix spike/matrix spike duplicate (MS/MSD) samples. Quality control data are generated as indicators of precision (relative percent difference or RPD) and accuracy (percent recovery) for a set of analytical measurements. Additional information regarding types of QA/QC samples is provided in the Sampling and Analysis Plan. Results of the QA/QC analyses, as indicated in Table 3-1 below, are provided in Appendix B, along with additional discussion of the results. Relevant QA/QC results, including MS/MSD and laboratory duplicate data, are summarized in this section (Section 3.0).

Table 3-1. Type of QA/QC for Each Parameter

General Chemistry	MS Recoveries/Duplicate Results	Table B-10
VOCs	Detection Limits MS/MSD Recoveries	Table B-1, Table B-3 Table B-5, Table B-11
SVOCs	Detection Limits MS/MSD Recoveries	Table B-2, Table B-4 Table B-6, Table B-12
Total Metals	MS/MSD Recoveries	Table B-7, Table B-13
TCLP Metals	MS Recoveries/Duplicate Results	Table B-8
General Chemistry	MS/MSD Recoveries Laboratory and Field Duplicates	Table B-9, Table B-14 Table B-9

3.1 Soil

3.1.1 Explosives

The QC data were not provided with the data package for explosives in the soil samples, although the results of the QC analyses were summarized in the narrative. It was stated that all surrogate recoveries were within the control limits. No information is available on the MS/MSD recoveries and RPDs. Based on the surrogate results, it appears that the precision and accuracy are acceptable, however, a complete assessment of the data quality is not possible without the full set of data.

3.1.2 VOCs

Matrix spike/matrix spike duplicate data are provided for VOCs in Table B-5. All results (both recoveries and RPDs) were within the control limits, so all the VOC data are considered to be of high quality, with good precision and accuracy.

3.1.3 SVOCs

Matrix spike/matrix spike duplicate data are provided for SVOCs in Table B-6. All results (both recoveries and RPDs) were within the control limits, so all the SVOC data are considered to be of high quality, with good precision and accuracy.

3.1.4 Total Metals

As shown in Table B-7, several of the MS/MSD recoveries for metals were outside the QC limits for accuracy. Mercury had a high recovery of the matrix spike but not the matrix spike duplicate. Only aluminum, iron, and lead were low by a significant margin, which would indicate a possible low bias in the reported analytical results. Thus, although the accuracy of the aluminum, iron, and lead results are questionable, the precision, or repeatability, is very good. It is believed that interferences in the sample matrix caused the erratic recoveries.

3.1.5 TCLP Metals

The matrix spike recoveries and laboratory duplicate results for the TCLP analysis are shown in Table B-8. Recoveries for all the metals were within the control limits, with the exception of silver, which was only two percent low. Silver was not detected in the sample, so even if the result was corrected for bias, the silver concentration would still be well below the regulatory limit. Accuracy and precision for all the other TCLP metals were acceptable, so the TCLP analysis was considered valid, including the one lead sample (Sample 7) that exceeded the regulatory limit.

3.1.6 General Chemistry

The QC results for the general inorganic chemistry parameters were somewhat inconsistent, as shown in Table B-9. The MS/MSD recoveries for cyanide were somewhat high, at 157 and 169 percent, respectively, but the RPD was low, indicating that the data may be biased high but the results were repeatable and precise. However, the laboratory and field duplicate RPDs (92 percent and 63 percent, respectively) are much higher than the MS/MSD RPDs, an indication of possible sample non-homogeneity. The sample results for cyanide, however, are so low as to not be of concern, especially considering they may be biased high.

MS/MSD recoveries for nitrate in soil were acceptable. The matrix spike was somewhat low but not of great concern. The RPD was slightly high, but also insignificant. The laboratory duplicate RPD was excellent, while the field duplicate was slightly higher. Although not perfect (the bias is a little low and there is some variability), the data quality is sufficient for evaluation of nitrate concentrations at the sample location.

No sulfide was found in any of the samples, including the MS/MSD samples. Matrix interference is believed to be the cause of the low recoveries, so the true measure of accuracy is not known and the sample concentrations may be underrepresented. Action levels are significantly higher than the detection limits, so even though the sample concentrations may be underrepresented, it is unlikely that sulfide is present at levels of concern.

3.2 Ground Water

3.2.1 Explosives

MS/MSD data are provided for explosives in Table B-10. The MS/MSD recoveries were acceptable for RDX and TNT. The MSD was just outside the control limits for DNT but should have only minimal impact on the data. All RPDs were acceptable. MS/MSD recoveries of HMX for the primary column were inflated, but the confirmation column recoveries were acceptable, so results from the confirmation column only were reported for HMX. Explosives data in general appears to be valid and of acceptable quality.

3.2.2 VOCs

Matrix spike/matrix spike duplicate data are provided for VOCs in Table B-11. All recovery results were within the control limits, and only one RPD was outside the limits. The benzene RPD was just slightly outside the control limits, and the compound was not even detected in the sample, so the impact to the data is minimal. Thus, the VOC data are considered to be of high quality, with good precision and accuracy.

3.2.3 SVOCs

Matrix spike/matrix spike duplicate data are provided for SVOCs in Table B-12. All results (both recoveries and RPDs) were within the control limits, so the SVOC data are considered to be of high quality, with good precision and accuracy.

3.2.4 Metals

As shown in Table B-13, all MS/MSD recoveries were acceptable, except for lead and mercury. Only the MSD was outside the control limits for mercury, by a very small, insignificant margin. The lead results reported are for analysis by atomic absorption (AA) and are very erratic. The recoveries for lead analyzed by ICP (Method 6010) were much improved and more appropriate for the concentration present, but the exact recovery values are not available.

3.2.5 General Chemistry

The QC results for the general inorganic chemistry parameters were somewhat inconsistent, as shown in Table B-14. The MS/MSD recoveries for cyanide were acceptable. The RPD was slightly high, but good enough for assessment of the level of contaminants found.

The QC (MS/MSD recoveries and RPDs) results for nitrate in groundwater were acceptable, as were the QC results for sulfide. Although the soil QC proved inconclusive for sulfide, in water the QC results showed definitively that no contamination was present at levels above the detection limit.

4.0 DETAILED ANALYTICAL RESULTS

4.1 Soil

Soil sampling was conducted in order to evaluate the contaminant concentrations present at the STTP. Sample locations are shown in Figure 3.

4.1.1 Explosives

Ten soil samples, including the field duplicate and background sample, were collected and analyzed for explosives. Explosives results for the soil samples are shown in Table A-1.

HMX and NG were found most frequently, in two of the 10 samples. HMX was found in Samples 1 and 8, at concentrations of 3.6 and 13 mg/kg, respectively. Nitroglycerine was found in Samples 6 and 8, at concentrations of 180 and 1.6 mg/kg, respectively. Hexahydro-1,2,5-trinitro-sym-triazine (RDX), dinitrobenzene (DNB), and DNT were each found in one sample. RDX was found in Sample 2 at 0.69 mg/kg; DNB was found in Sample 7 at 4.8 mg/kg, and DNT was found in Sample 7 at 6.0 mg/kg. No TNT was found in any of the samples.

None of the analyzed explosives were found in Samples 3, 9 (duplicate of 3), 4, 5, or 10 (background). The sample locations are shown in Figure 3. There are no apparent trends in the occurrence of explosives as related to sample location at the Safety Thermal Treatment Point.

The applicable explosives compounds were compared to the Proposed RCRA Corrective Action Levels, the Region III Risk-Based Concentrations, and the Draft OSWER Soil Screening Guidance. Dinitrotoluene was the only compound with concentrations exceeding the corrective action or screening levels. The combined concentration of 2,4-dinitrotoluene and 2,6-dinitrotoluene (i.e., 6.0 mg/kg) in Sample 7 was several times higher than the SSL for the migration to ground-water pathway for both 2,4-DNT and 2,6-DNT. It was also several times higher than the Proposed RCRA Action Level for a DNT isomeric mixture and for the RBCs for DNT isomeric mixtures as listed in the Region III guidance.

4.1.2 VOCs

Ten soil samples, including a field duplicate and a background sample, were collected and analyzed for the Appendix IX list of volatile organic compounds. The results are shown in Table A-2. Only analytes that were detected at levels greater than the detection limit are shown in Table A-2. Detection limits for all target analytes are shown in Table B-1 (in Appendix B of this report).

Only very small quantities of VOCs were found in the soil samples. VOCs present were burned off during activities at the STTP. Only acetone, at 14 μg/kg was found at a level above (but very close to) the detection limit in the field duplicate sample, Sample 9. No acetone was detected in Sample 3, the other sample of the duplicate pair. All other identifications of target analytes were at a level below the detection limit, and were comparable to the concentrations found in the background sample.

All of the VOC concentrations were well below the corrective action and screening levels.

4.1.3 SVOCs

Seven soil samples, including a field duplicate and a background sample, were collected and analyzed for the Appendix IX list of semivolatile organic compounds. The results are shown in Table A-3. Only analytes that were detected at levels greater than the detection limit are shown in Table A-3. Detection limits for all target analytes are shown in Table B-2 (in Appendix B of this report).

Only diethylphthalate, 2,4-dinitrotoluene, and 5-nitro-o-toluidine were found at concentrations above the detection limit. The 2,4-dinitrotoluene and 5-nitro-o-toluidine were found at 1,800 μg/kg and 410 μg/kg, respectively, in Sample 3. Diethylphthalate was found in Sample 6 at 520 μg/kg and at 2,000 μg/kg in the background (Sample 10).

2,4-DNT was also found in Sample 9 (the field duplicate of Sample 3), at a concentration below the detection limit. Several other compounds were found at concentrations below the detection limit including: di-n-butyl phthalate and dimethyl phthalate in Sample 6; bis(2-ethylhexyl)phthalate in Samples 3, 6, and 9; and pyridine in Sample 3.

Many polynuclear aromatic hydrocarbons, including benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, benzoic acid, chrysene, fluoranthene, and pyrene, were detected in the background sample, Sample 10, at concentrations below detection limit. No analytes were detected in Samples 1, 2, and 5. The only concentration significantly higher than the background is for 2,4-DNT in Sample 3. However, this concentration is still less than five times the detection limit, the level below which is associated with higher uncertainty. It is possible that semivolatiles were burned off at the STTP, but not in the background soil.

In addition, several Tentatively Identified Compounds (TICs) were identified. The highest concentration TIC, occurring most frequently, was 4-hydroxy-4-methyl-2-pentanone (acetonylmethylcarbinol, or diacetone alcohol), ranging from 18,000 μg/kg in the background to 30,000 μg/kg in Sample 2. This analyte was also found in the laboratory blank, and may be a product of the extraction. Additional TICs were identified, at concentrations from 240 -

4,500 $\mu g/kg$ in one to three of the samples. Samples 6 and 9 contain the largest number of TICs, with six and eight, respectively.

All SVOCs were below the Proposed RCRA Corrective Action Levels for all applicable compounds. The benzo(a)pyrene (BaP) detection limits, as well as the BaP concentration of Sample 10 (the background sample) exceeded the SSL for the ingestion pathway. The detection limits were approximately five times higher than the screening levels, and the background concentration (below the detection limit) was approximately twice the screening levels. The SSL ground-water pathway for 2,4-DNT was also exceeded by the 2,4-DNT detection limits (by a factor of two) and by Sample 3 (by a factor of nine) and its field duplicate, Sample 9 (by less than a factor of two). This illustrates that the screening levels are sometimes more stringent than routinely achievable analytical levels.

4.1.4 Total Metals

Ten samples, including a field duplicate and a background sample, were collected and analyzed for twenty-one metals. The results are shown in Table A-4. All but three of the analytes (antimony, silver, and thallium) were detected in the background sample (Sample 10). Because trace metals commonly occur in soil, the sample results were first compared to the background results. The following metals had one or more measurements greater than five times the background concentration: barium, cadmium, chromium, copper, lead, mercury, nickel, and sodium. Many of these metals, including barium, lead, and mercury, are commonly used in explosives. Sample 3 and its field duplicate (Sample 9) in general had the highest metals concentrations, with five and six analytes, respectively, at levels greater than five times the background. Samples 2 and 6 also had five and six analytes, respectively, at levels greater than five times the background, with concentrations somewhat lower than in Samples 3 and 9. Samples 1, 4, 5, and 7 had no concentrations greater than five times the background.

The metals concentrations were compared to typical background levels for soils in the eastern U.S.; concentrations of barium (in Sample 3), lead (in Samples 6, 7, and 9), mercury (in Samples 6 and 8), and tin (in Samples 3 and 6) were greater than the observed range for the eastern U.S. Tin was also found at similar, low concentrations in the blank associated with the metals analysis, so the high tin values are most likely attributable to laboratory contamination.

Other relevant findings from metal analysis results are:

- Beryllium concentrations for all samples except Sample 4 and Sample 5 were at or above the Proposed RCRA Corrective Action Level and the Region III Screening Level (residential), by up to a factor of two.

- Manganese concentrations in all soil samples were slightly higher than the Region III screening level (residential).

- Arsenic concentrations for all of the samples were greater than the Region III screening level for arsenic as a carcinogen but lower than the screening value for non-carcinogenic arsenic.

- Lead concentrations for all samples were greater than the Region III screening values for lead (tetraethyl lead), but it is unlikely that all of the lead present is in that form.

- Concentrations for arsenic, barium, beryllium, cadmium, chromium, lead, mercury, and nickel all exceeded the draft SSLs for those elements.

4.1.5 TCLP Metals

TCLP metals analysis was performed on 10 samples from the same 10 sample locations as the total metals analysis. The TCLP results are shown in Table A-5.

Only one analyte for one sample exceeded the regulatory limits. Sample 7 was 10,400 μg/L for lead, versus a RCRA limit of 5,000 μg/L. Sample 7 does not contain the highest total lead concentration, but the pH, particle size distribution, and other properties of the soil may affect the leachability.

4.1.6 General Chemistry

Ten samples were collected and analyzed for cyanide, nitrate, and sulfide. The results of these analyses are shown in Table A-6. Cyanide was found in four of ten samples, with the highest concentration being 2.82 mg/kg in Sample 6. Nitrate was found in all samples, with concentrations ranging from 0.259 mg/kg in Sample 4 to 6.72 mg/kg in Sample 6. The background concentration (Sample 10) was 2.84 mg/kg nitrate. No sulfide was detected in any of the samples. Sulfide detection limits for most of the samples were near 50 mg/kg. All of these inorganic, general chemistry parameters had concentrations well below the regulatory and screening levels.

4.2 Ground Water

The ground water was sampled to determine whether various activities at STTP affected the underlying aquifer. Five samples were collected and analyzed for each parameter, including a field duplicate and a background sample. The sample locations for ground water are shown in Figure 3. The parameters monitored in the ground water were the same as those measured in the soil samples. Ground-water results were compared to Maximum Contaminant Levels (MCLs), Proposed RCRA Action Levels, and Region III screening levels (for tap water).

4.2.1 Explosives

Five ground-water samples, including a field duplicate and a background sample, were collected and analyzed for explosives. The ground-water samples were analyzed for HMX, RDX, TNT, DNT, and NG. These results are shown in Table A-7. HMX was found in the

W3 sample and its field duplicate, with excellent agreement (1.1 mg/L). TNT was found in the W1 sample at a concentration of 0.84 mg/L. No other explosives were detected in any of the ground-water samples. The concentration of TNT in the W1 sample was several hundred times greater than the Region III screening level for 2,4,6-TNT. The concentration of HMX was lower than the Region III screening level.

4.2.2 VOCs

Five ground-water samples, including a field duplicate and a background sample, were collected and analyzed for the Appendix IX list of volatile organic compounds. The results are shown in Table A-8. Only analytes that were detected at levels greater than the detection limit are shown in Table A-8. Detection limits for all target analytes are shown in Table B-3 (in Appendix B of this report).

Only 1,2-dichloroethene was detected at a level greater than the detection limit, with the highest concentration being 8 μg/L in the W3 sample. Total xylenes and trichlorofluoroethane were also detected in several samples at or below the detection limit. No VOCs were detected in the background sample. No TICs were identified and reported. All VOC concentrations found in the STTP ground-water samples were below the applicable MCLs, action levels, and screening levels.

4.2.3 SVOCs

Five ground-water samples, including a field duplicate and a background sample, were collected and analyzed for the Appendix IX list of semivolatile organic compounds. The results are shown in Table A-9. Only analytes that were detected at levels greater than the detection limit are shown in Table A-9. Detection limits for all target analytes are shown in Table B-4 (in Appendix B of this report).

Only one compound, pyridine, was detected at a concentration greater than the detection limit. It was found in the W3 and field duplicate samples, at concentrations of 33 μg/L and 79 μg/L, respectively. Diethylphthalate (W1 sample) and bis(2-ethylhexyl)phthalate (W3 and field duplicate samples) were also found at concentrations below the detection limit. No SVOC target analytes were detected in the W2 sample or the background sample.

Three TICs were identified. 4-Hydroxy-4-methyl-2-pentanone, 2-ethyl-1-hexanol, and 4,4'-butylidene bis (2-phenol) were all found in the background sample. 4-Hydroxy-4-methyl-2-pentanone (acetonylmethylcarbinol, or diacetone alcohol), was found in all the ground-water samples at 55-73 μg/L and was also found in the soil samples. This compound is believed to be a laboratory contaminant or a product of the extraction. An unknown phenol was also identified in four of the five ground-water samples.

The concentrations of bis(2-ethylhexyl)phthalate detected in the W3 and field duplicate samples (at a concentration below the detection limit) were below the MCL of 6 μg/L for the compound. However, the detection limit of 11 μg/L is greater than the MCL. The Region III screening value is just below the concentration detected in the W3 and field duplicate samples. The bis(2-ethylhexyl)phthalate concentrations detected in the ground-water samples for the compound are attributable to laboratory contamination anyway. The pyridine concentration in the W3 field duplicate sample is above both the proposed RCRA Action Level and the Region III Screening level, by a factor of two. The pyridine concentration in the W3 sample is just below these levels.

4.2.4 Metals

Five ground-water samples, including a field duplicate and a background sample, were collected and analyzed for twenty-one metals. The results are shown in Table A-10. Because trace amounts of metals commonly occur in ground water, the sample results were compared to the background results. The W1 sample appears to have the highest concentrations of analyzed metals, including aluminum, barium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, potassium, silver, sodium, vanadium, and zinc. The W3 sample and field duplicate samples have the highest concentrations of calcium, magnesium, and potassium, as well as several concentrations significantly greater than five times above background levels (including barium, lead, manganese, and zinc). None of the metals analyzed were found at levels greater than five times the detection limit in the background.

The Action Level for lead (15 μg/L) proscribed by the Primary Drinking Water Standards was exceeded in every sample, including the background sample. The Region III screening level (for tetraethyl lead) was also exceeded by several thousand times. The MCL for cadmium was exceeded slightly in the W1 sample, and the MCL for mercury was exceeded by ten times in the W1 sample. The Region III screening level for mercury was also exceeded in the W1 sample. For beryllium, both the concentration of the W1 sample (1.9 μg/L) and the detection limit (1.0 μg/L) exceeded the proposed RCRA Corrective Action Level and the Region III screening level by more than a hundred times. Although antimony was not detected in the STTP ground-water samples, the detection limit exceeded both the Proposed RCRA Corrective Action Level and the Region III screening level. The Region III screening level of 180 μg/L was also exceeded for manganese in the W1, W2, and W3 samples.

4.2.5 General Chemistry

Five ground-water samples, including a field duplicate and a background sample, were collected and analyzed for cyanide, nitrate, and sulfide. The results of these analyses are shown in Table A-11. For cyanide, the W1 sample, at 212 μg/L, exceeded the MCL for cyanide of 200 μg/L, but was below the Proposed RCRA Corrective Action Level and the Region III screening level. The only other detected concentration was just over the detection limit, in the W3 sample. Nitrate was detected in all five samples, at concentrations ranging from 26 μg/L in the W1 sample to 1,170 μg/L in the W2 sample. All nitrate concentrations were below guidance and screening levels. Sulfide was not found in any of the ground-water samples, and detection limits were well below the regulatory and screening levels.

5.0 REFERENCES

1. Versar, December 18, 1992. Final Sampling and Analysis Plan for Clean Closure of the Safety Thermal Treatment Plant.

2. USEPA, July 27, 1990. Proposed RCRA Action Levels (Proposed Rule), Federal Register, Vol. 55, No. 145, pp. 30865-30884.

3. USEPA Region III, January 1993. Technical Guidance Manual. Selecting Exposure Routes and Contaminants of Concern by Risk-Based Screening. EPA/903/R-93-001.

4. USEPA Office of Solid Waste and Emergency Response, December 1994. Soil Screening Guidance, EPA/540/R-94/101, PB95-963529.

5. Hansford, T. Shacklette and Josephine G. Boerngen, 1984. US Geological Survey Professional Paper 1270. United States Printing Office: Washington, DC.

6. US Department of Agriculture, Forest Service, February 1990. A Summary of Background Concentrations for 17 Elements in North American Soils.

7. USEPA Office of Water, May 1994. Drinking Water Regulations and Health Advisories, EPA 822-R-94-001.

APPENDIX A

ANALYTICAL RESULTS-TABLES

Table A-1
Indian Head - Safety Thermal
Treatment Plant Soils Sampling
Explosives Results (mg/kg)

Compound	Sample Number									
	1	2	3	9 (Sample 3 Field Duplicate)	4	5	6	7	8	10 (Background Sample)
HMX	13/9.8[a]	ND (0.50)	ND (0.50)	ND (0.50)	ND (0.50)	ND (0.50)	ND (0.50)	ND (0.50)	4.3/3.6[a]	ND (0.50)
RDX	ND (0.59)	0.69	ND (0.59)	ND (0.59)	ND (0.59)	ND (0.59)	ND (0.59)	ND (0.59)	ND (0.59)	ND (0.59)
DNB	ND (0.42)	ND (0.42)	ND (0.42)	ND (0.42)	ND (0.42)	ND (0.42)	ND (0.42)	4.8	ND (0.42)	ND (0.42)
TNT	ND (0.44)	ND (0.44)	ND (0.44)	ND (0.44)	ND (0.44)	ND (0.44)	ND (0.44)	ND (0.44)	ND (0.44)	ND (0.44)
DNT[b]	ND (0.82)	ND (0.82)	ND (0.82)	ND (0.82)	ND (0.82)	ND (0.82)	ND (0.82)	6.0	ND (0.82)	ND (0.82)
NG	ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)	180	ND (1.0)	1.6	ND (1.0)

NOTES:

ND = Not detected at the detection limit in parenthesis.
Sample numbers 3 and 9 are duplicates.
Sample 10 is the background sample.
All results mg/kg or parts per million (ppm).

[a] Only confirmed identifications of HMX are reported; the result from the primary column is shown first, followed by the result from the confirmation column.
[b] Mixture of 2,6-DNT and 2,4-DNT.

Table A-2
Indian Head - Safety Thermal
Treatment Plant Soils Sampling
Volatile Organic Results ($\mu g/kg$)

Compound	Sample Number									
	1	2	3	9 (Field Dupl. of Sample 3)	4	5	6	7	8	10 (Background Sample)
Acetone	ND (12)	ND (12)	ND (12)	14	ND (11)	8[a] (11)	ND (11)	ND (12)	ND (11)	ND (11)
Methylene Chloride	ND (6)	ND (6)	ND (6)	ND (6)	ND (6)	ND (5)	ND (6)	ND (6)	ND (6)	1[a] (5)
Tetrachloroethene	3[a] (6)	1[a] (6)	ND (6)	ND (6)	ND (6)	ND (5)	ND (6)	ND (6)	ND (6)	ND (5)
Toluene	0.4[a] (6)	ND (6)	ND (6)	ND (6)	ND (6)	ND (5)	0.7[a] (6)	ND (6)	0.9[a] (6)	2[a] (5)
Trichloroethene	ND (6)	ND (6)	ND (6)	ND (6)	ND (6)	1[a] (5)	ND (6)	ND (6)	ND (6)	ND (5)
Total Xylenes	ND (6)	ND (6)	ND (6)	ND (6)	ND (6)	ND (5)	ND (6)	ND (6)	0.5[a] (6)	1[a] (5)

NOTES:

ND = Not detected at the detection limit in parenthesis.
Sample numbers 3 and 9 are duplicates.
Sample number 10 is the background sample.
All results $\mu g/kg$ or parts per billion (ppb).
This table only presents data for compounds that were detected in at least one sample.

[a] Estimated value. This compound was detected at a concentration below the detection limit shown in parentheses.

Table A-3
Indian Head - Safety Thermal
Treatment Plant Soils Sampling
Semivolatile Organic Results
(μg/kg)

Compound	Sample Number						
	1	2	3	9 (Field Dupl. of Sample 3)	5	6[d]	10 (Background Sample)
Benzo(b)fluoranthene	ND (410)	ND (490)	ND (410)	ND (410)	ND (350)	ND (390)	210[c] (390)
Benzo(k)fluoranthene	ND (410)	ND (490)	ND (410)	ND (410)	ND (350)	ND (390)	270[c] (390)
Benzo(a)pyrene	ND (410)	ND (490)	ND (410)	ND (410)	ND (350)	ND (390)	170[c] (390)
Benzoic acid	ND (2,000)	ND (2,400)	ND (2,000)	ND (2,000)	ND (1,700)	ND (1,900)	260[c] (1,900)
Chrysene	ND (410)	ND (490)	ND (410)	ND (410)	ND (350)	ND (390)	250[c] (390)
Di-n-butylphthalate	ND (410)	ND (490)	ND (410)	ND (410)	ND (350)	150[c] (390)	ND (390)
Diethylphthalate	ND (410)	ND (490)	ND (410)	ND (410)	ND (350)	520	2,000
Dimethylphthalate	ND (410)	ND (490)	ND (410)	ND (410)	ND (350)	130[c] (390)	ND (390)
2,4-Dinitrotoluene	ND (410)	ND (490)	1,800	240[c] (410)	ND (350)	ND (390)	ND (390)
bis(2-Ethylhexyl)phthalate	ND (410)	ND (490)	400[c] (410)	220[c] (410)	ND (350)	200[c] (390)	ND (390)
Fluoranthene	ND (410)	ND (490)	ND (410)	ND (410)	ND (350)	ND (390)	220[c] (390)
5-Nitro-o-toluidine	ND (410)	ND (490)	410	ND (410)	ND (350)	ND (390)	ND (390)
Pyrene	ND (410)	ND (490)	ND (410)	ND (410)	ND (350)	ND (390)	260[c] (390)
Pyridine	ND (810)	ND (980)	450[c] (810)	ND (820)	ND (690)	ND (780)	ND (780)
Tentatively Identified Compounds[a]							
Benzenamine, 2-nitro-n-phenyl	--	--	--	--	--	1,300	470
Benzene, 1-methyl-2-nitro-	--	--	320	--	--	--	--
Carbonochloridic acid, 4-nitro	--	--	1,900	490	--	--	--
Cyclopentadecanone, 2-hydroxy	--	--	--	--	--	--	240
o,p-DDT	--	--	--	--	--	--	360

1128\appendxa.ih

Table A-3
(Continued)

Compound	Sample Number						
	1	2	3	9 (Field Dupl. of Sample 3)	5	6[d]	10 (Background Sample)
Decanedioic acid, dibutyl ester	--	--	--	410	--	--	--
Ethane, 1,2,2-trichloro-1,1-	--	--	--	--	--	4,500	--
Hexadecanoic acid	--	--	--	740	--	1,300	--
Octadecanoic acid, butyl ester	--	--	--	1,400	--	--	--
9-Octadecenamide, (Z)-	--	850	--	--	--	--	--
2-Pentanone, 4-hydroxy-4-methyl	22,000[b]	30,000[b]	22,000[b]	20,000[b]	19,000[b]	19,000[b]	18,000[b]
14-Pentadecenoic acid	--	980	--	--	--	550[c]	--
Phosphoric acid, tris(2-ethyl)	--	--	810[c]	1,300	--	2,300[c]	--
Sulfur, mol. (S8)	--	--	--	490[c]	--	--	--
Tetradecanoic acid	--	--	--	1,500[c]	--	--	--

NOTES:

ND = Not detected at the detection limit in parenthesis.
Sample numbers 3 and 9 are duplicates.
All results μg/kg or parts per billion (ppb).
This table only presents data for compounds that were detected in at least one sample.

[a] All tentatively identified compounds (TICs) are considered to be estimated values.
[b] This analyte was found in the laboratory blank as well as in the sample. Thus, the presence of the analyte in the sample may be attributable to laboratory contamination.
[c] This analyte was detected at a concentration below the detection limit shown in parentheses.
[d] The internal standard area abundance value for Sample 6 did not meet the method-specified QC limits. Reanalysis was performed and the outlier value was replicated. This occurrence is an indication of matrix interference in the sample.

Table A-4
Indian Head - Safety Thermal
Treatment Plant Soils Sampling
Total Metals Results (mg/kg)

Metal	Sample Number									
	1	2	3	9 (Field Dupl. for Sample 3)	4	5	6	7	8	10 (Background Sample)
Aluminum	8,060	9,220	11,100	10,400	478	207	6,740	5,100	3,960	2,950
Antimony	ND (2.8)	5.0	4.0	4.3	ND (2.4)	ND (2.5)	3.0	ND (2.5)	ND (2.7)	ND (2.7)
Arsenic	16.5	2.9	6.9	9.2	0.70	0.79	5.1	6.8	2.8	6.9
Barium	53.3	382	1,550	963	11.2	6.2	67.5	84.9	31.3	53.9
Beryllium	0.27	0.26	0.35	0.30	ND (0.10)	ND (0.10)	0.33	0.20	0.22	0.28
Cadmium	1.9	14.8	6.6	5.8	0.32	ND (0.31)	0.84	0.31	0.38	0.46
Calcium	475	986	2,010	1,220	142	118	320	789	463	943
Chromium	14.9	44.6	101	76.8	4.5	1.9	48.1	21.8	9.7	9.5
Cobalt	3.8	8.2	14.2	13.6	1.7	1.3	9.5	17.4	3.4	4.3
Copper	29.5	362	133	137	3.1	1.7	44.0	16.0	22.8	26.8
Iron	14,400	14,000	27,300	24,500	3,450	2,520	19,300	16,100	10,400	9,330
Lead	48.8	188	287	382	6.9	4.1	1,010	522	280	106
Magnesium	490	749	1,150	934	88.2	58.5	458	298	300	532
Manganese	75.9	298	198	174	116	86.7	131	485	65.6	138
Mercury	0.24	1.6	0.13	0.16	ND (0.05)	ND (0.05)	3.8	0.54	4.4	0.24
Nickel	13.6	38.5	55.5	42.8	3.0	1.6	70.4	5.3	4.7	6.4
Potassium	675	604	976	836	ND (138)	ND (143)	488	495	278	390
Selenium	0.29	0.17	0.15	0.19	ND (0.097)	ND (0.10)	0.13	0.16	0.13	0.25
Silver	ND (2.3)	ND (2.5)	ND (4.6)	ND (2.4)	ND (2.0)	ND (2.1)	ND (2.2)	ND (2.1)	ND (2.2)	ND (2.2)
Sodium	13.4	63.5	1,040	575	9.3	5.3	23.7	46.7	41.0	56.9
Thallium	ND (0.23)	ND (0.24)	ND (0.24)	ND (0.24)	ND (0.19)	ND (0.20)	ND (0.22)	ND (0.20)	ND (0.21)	ND (0.23)

1128\appendxa.ih

Table A-4
Indian Head - Safety Thermal
Treatment Plant Soils Sampling
Total Metals Results (mg/kg)
(Continued)

Metal	Sample Number									
	1	2	3	9 (Field Dupl. for Sample 3)	4	5	6	7	8	10 (Background Sample)
Vanadium	27.8	22.1	28.5	26.4	5.0	3.7	22.5	19.4	14.8	15.6
Zinc	36.5	238	96.7	150	12.9	9.5	97.9	178	81.8	79.4
Tin	4.0[a]	8.5[a]	12.8[a]	9.8[a]	6.1[a]	5.6[a]	11.3[a]	3.5[a]	6.0[a]	4.0[a]

NOTES:

ND = Not detected at the detection limit in parenthesis.
Sample numbers 3 and 9 are field duplicates.
Sample number 10 is the background sample.
All results mg/kg or parts per million (ppm).

[a] This analyte was found at 7.6 mg/kg in the laboratory blank, so the concentrations detected in the rest of the samples may be attributed to laboratory contamination.

Table A-5
Indian Head - Safety Thermal
Treatment Plant Soils Sampling
TCLP Results[a] (ug/l)

Metal	Sample Number										
	1	2	3	9 (Sample 3 Field Dupl.)	4	5	6	7	8	10 (Background Sample)	TCLP Regulatory Limits
Arsenic	ND(210)	ND(210)	ND(210)	ND(210)	ND(210)	ND(210)	ND(210)	ND(210)	ND(210)	ND(210)	5,000
Barium	773	1,920	6,090	4,860	300	185	765	780	368	321	100,000
Cadmium	ND(30.0)	128	ND(30.0)	52.5	ND(30.0)	ND(30.0)	ND(30.0)	ND(30.0)	ND(30.0)	ND(30.0)	1,000
Chromium	29.0	ND(20.0)	45.2	33.5	ND(20.0)	ND(20.0)	ND(20.0)	ND(20.0)	ND(20.0)	ND(20.0)	5,000
Lead	403	ND(240)	390	925	ND(240)	ND(240)	3,060	10,400[b]	2,070	ND(240)	5,000
Mercury	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	ND(5.0)	200
Selenium	ND(10.0)	ND(10.0)	ND(10.0)	ND(10.0)	ND(10.0)	ND(10.0)	ND(10.0)	ND(10.0)	20.0	ND(10.0)	1,000
Silver	ND(40.0)	ND(40.0)	ND(40.0)	ND(40.0)	ND(40.0)	ND(40.0)	ND(40.0)	ND(40.0)	ND(40.0)	ND(40.0)	5,000

NOTES:

ND = Not detected at the detection limit in parenthesis.
Sample numbers 3 and 9 are field duplicates.
Sample number 10 is the background sample.
All results ug/l or parts per billion (ppb).

[a] Not bias corrected per the Federal Register (40 CFR 261 and 271) amendment to Method 1311, Vol. 57, No. 227, November 24, 1992.
[b] Above regulatory limit for TCLP.

Table A-6
Indian Head - Safety Thermal
Treatment Plant Soils Sampling
General Inorganic Chemistry Results

Lab Number	Field Number	Cyanide (mg/kg)	NO_3-N (mg/kg)	Sulfide (mg/kg)
86192	1	ND (0.625)	1.37	ND (83.0)
86193	2	ND (0.654)	2.51	ND (261)
86194	3	2.28	0.428	ND (82.1)
86195	4	ND (0.525)	0.259	ND (52.3)
86196	5	ND (0.521)	0.335	ND (41.6)
86197	6	2.82	6.72	ND (76.4)
86198	7	0.761	5.31	ND (43.5)
86199	8	ND (0.543)	0.339	ND (56.5)
86200	9 (Sample 3 Field Dupl.)	1.19	1.34	ND (48.7)
86201	10 (Background Sample)	ND (0.597)	2.84	ND (237)

NOTES:

ND = Not detected at the detection limit in parentheses.
Sample numbers 3 and 9 are field duplicates.
Sample number 10 is the background sample.

Table A-7
Indian Head - Safety Thermal
Treatment Plant Ground-water Sampling
Explosives Results (mg/L)

Compound	Sample				
	W2	W1	W3	W3 Duplicate (Field Duplicate)	Background
HMX[a]	ND (0.64)	ND (0.64)	1.1	1.1	ND (0.64)
RDX	ND (0.40)	ND (0.40)	ND (0.40)	ND (0.40)	ND (0.40)
TNT	ND (0.34)	0.84	ND (0.34)	ND (0.34)	ND (0.34)
DNT[b]	ND (0.69)	ND (0.69)	ND (0.69)	ND (0.69)	ND (0.69)
NG	ND	ND	ND	ND	ND

NOTES:

ND = Not detected at the detection limit in parenthesis.
All results mg/L or parts per million (ppm).

[a] HMX results are from the confirmation column because the QC results from the primary column showed inflated recoveries.
[b] Mixture of 2,6-DNT and 2,4-DNT.

Table A-8
Indian Head - Safety Thermal
Treatment Plant Ground-water Sampling
Volatile Organic Results ($\mu g/L$)

Compound	Sample				
	W2	W1	W3	W3 Duplicate (Field Duplicate)	Background
Total Xylenes	ND (6)	3[a] (5)	ND (5)	ND (5)	ND (5)
1,2-Dichloroethene	ND (5)	ND (5)	8	7	ND (5)
Trichlorotrifluoroethane	5	ND (5)	4[a] (5)	ND (5)	ND (5)

NOTES:

ND = Not detected at the detection limit in parenthesis.
All results $\mu g/L$ or parts per billion (ppb).
This table only presents data for compounds that were detected in at least one sample.

[a] Estimated value. This compound was detected at a concentration below the detection limit shown in parentheses.

Table A-9
Indian Head - Safety Thermal
Treatment Plant Ground-water Sampling
Semivolatile Organic Results (μg/L)

Compound	Sample				
	W2	W1	W3	W3 Duplicate (Field Duplicate)	Background
Diethylphthalate	ND (11)	5[c] (11)	ND (12)	ND (10)	ND (11)
bis(2-Ethylhexyl)phthalate	ND (11)	ND (11)	5[b,c] (12)	5[b,c] (10)	ND (11)
Pyridine	ND (21)	ND (22)	33	79	ND (22)
Tentatively Identified Compounds[a]					
2-Pentanone, 4-hydroxy-4-methyl	55[b,d]	73[b,d]	68[b,d]	65[b,d]	71[b,d]
1-Hexanol, 2-ethyl	--	--	--	--	10
Phenol, 4,4'-Butylidene bis(2	12	--	16	9.1	9.8

NOTES:

ND = Not detected at the detection limit in parenthesis.
All results μg/L or parts per billion (ppb).
This table only presents data for compounds that were detected in at least one sample.

[a] All tentatively identified compounds (TICs) are considered to be estimated values.

[b] This analyte was found in the laboratory blank as well as in the sample. Thus, the presence of the analyte in the sample may be attributable to laboratory contamination.

[c] This analyte was detected at a concentration below the detection limit shown in parentheses.

[d] This compound is believed to be a product of the extraction.

Table A-10
Indian Head - Safety Thermal
Treatment Plant Ground-water Sampling
Total Metals Results ($\mu g/L$)

Compound	Sample				
	W2	W1	W3	W3 Duplicate (Field Duplicate)	Background
Aluminum	1,080	29,800	8,590	5,370	7,710
Antimony	ND (24)	ND (24)	ND (24)	ND (24)	ND (24)
Arsenic	2.2	34.6	35.9	24.5	15.9
Barium	30.5	1,100	369	296	58.8
Beryllium	ND (1.0)	1.9	ND (1.0)	ND (1.0)	ND (1.0)
Cadmium	ND (4.0)	5.4	ND (4.0)	ND (4.0)	ND (4.0)
Calcium	20,400	13,800	74,300	64,200	5,630
Chromium	30.2	70.3	36.2	20.8	14.3
Cobalt	3.5	24.6	10.2	4.5	3.6
Copper	22.0	586	68.1	30.6	29.7
Iron	4,000	63,900	15,200	9,050	9,250
Lead	25.6	5,110	316	200	28.8
Magnesium	4,210	6,610	15,100	14,200	2,590
Manganese	338	825	224	166	77.7
Mercury	ND (0.2)	22	ND (0.2)	ND (0.2)	ND (0.2)
Nickel	27.7	87.1	15.4	18.7	ND (13)
Potassium	2,370	6,840	7,850	7,010	1,080
Selenium	1.5	2.3	1.2	1.2	1.5
Silver	ND (4.0)	10.6	ND (4.0)	ND (4.0)	ND (4.0)
Sodium	6,520	66,600	34,700	34,800	37,600
Thallium	ND (2.0)	ND (2.0)	ND (2.0)	ND (10)	ND (2.0)
Vanadium	4.9	99.2	23.7	12.4	20.7
Zinc	37.6	2,500	255	155	83.2
Tin	ND (9.0)	ND (9.0)	ND (9.0)	ND (9.0)	ND (9.0)

NOTES:

ND = Not detected at the detection limit in parenthesis.
All results $\mu g/L$ or parts per billion (ppb).

Table A-11
Indian Head - Safety Thermal
Treatment Plant Ground-water Sampling
General Inorganic Chemistry Results

Field Number	Cyanide ($\mu g/L$)	NO_3-N ($\mu g/L$)	Sulfide ($\mu g/L$)
W2	ND (10)	1,170	ND (2.0)
W1	212	26	ND (4.0)
W3	10.6	153	ND (2.0)
W3 Duplicate	ND (10)	116	ND (2.0)
Background	ND (10)	330	ND (2.0)

NOTES:

ND = Not detected at the detection limit in parentheses.

APPENDIX B

QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) RESULTS

QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) RESULTS

Soil

Explosives

The QC data were not provided with the data package for explosives in the soil samples, although the results of the QC analyses were summarized in the narrative. It was stated that all surrogate recoveries were within the control limits. No information is available on the MS/MSD recoveries and RPDs. Based on the surrogate results, it appears that the precision and accuracy are acceptable, however, a complete assessment of the data quality is not possible without the full set of data.

VOCs

Detection limits obtained for analysis of VOCs in soil are shown in Table B-1. These limits represent the concentration at which a compound can be positively identified with confidence. The level of uncertainty associated with quantitation between one and five times the detection limit is greater than that for values above five times the detection limit.

Matrix spike/matrix spike duplicate data are provided for VOCs in Table B-5. All results (both recoveries and RPDs) were within the control limits, so all the VOC data are considered to be of high quality, with good precision and accuracy.

SVOCs

Detection limits obtained for analysis of SVOCs in soil are shown in Table B-2. These limits represent the concentration at which a compound can be positively identified with confidence. The level of uncertainty associated with quantitation between one and five times the detection limit is greater than that for values above five times the detection limit.

Matrix spike/matrix spike duplicate data are provided for SVOCs in Table B-6. All results (both recoveries and RPDs) were within the control limits, so all the SVOC data are considered to be of high quality, with good precision and accuracy.

Total Metals

As shown in Table B-7, several of the MS/MSD recoveries for metals were outside the QC limits for accuracy. The analytes with low recoveries were aluminum, antimony, arsenic, chromium, iron, lead, nickel, and selenium. Mercury had a high recovery of the matrix spike but not the matrix spike duplicate. Only aluminum, iron, and lead were low by a significant margin, which would indicate a possible low bias in the reported analytical results. Only one RPD was outside the QC limits for precision - the arsenic RPD was 22 percent, just slightly outside the specified range of 0-20 percent. Thus, although the accuracy of the aluminum, iron, and lead results are questionable, the precision, or repeatability, is very good. It is believed that interferences in the sample matrix caused the erratic recoveries.

TCLP Metals

The matrix spike recoveries and laboratory duplicate results for the TCLP analysis are shown in Table B-8. Recoveries for all the metals were within the control limits, with the exception of silver, which was only two percent low. Silver was not detected in the sample, so even if the result was corrected for bias, the silver concentration would still be well below the regulatory limit. Accuracy and precision for all the other TCLP metals were acceptable, so the TCLP analysis was considered valid, including the one lead sample (Sample 7) that exceeded the regulatory limit.

General Chemistry

The QC results for the general inorganic chemistry parameters were somewhat inconsistent, as shown in Table B-9. The MS/MSD recoveries for cyanide were somewhat high, at 157 and 169 percent, respectively, but the RPD was low, indicating that the data may be biased high but the results were repeatable and precise. However, the laboratory and field duplicate RPDs (92 percent and 63 percent, respectively) are much higher than the MS/MSD RPDs, an indication of possible sample non-homogeneity. The concentration of the field duplicate samples was less than five times the detection limit, a level associated with higher uncertainty, so the 63 percent RPD is within the expected limits of 0-100 percent. The sample results for cyanide, however, are so low as to not be of concern, especially considering they may be biased high.

MS/MSD recoveries for nitrate in soil were acceptable. The matrix spike was somewhat low but not of great concern. The RPD was slightly high, but also insignificant. The laboratory duplicate RPD was excellent, while the field duplicate was higher. The field duplicate is generally expected to have a wider RPD (more uncertainty) because it is a measure of error contributions from both analytical and sampling (laboratory and field) procedures. Also, the field duplicate samples were of lower concentration (less than five times the detection limit) than were the laboratory duplicates; method variability is known to decrease with increasing concentration. Although not perfect (the bias is a little low and there is some variability), the data quality is sufficient for evaluation of nitrate concentrations at the sample location.

No sulfide was found in any of the samples, including the MS/MSD samples. Matrix interference is believed to be the cause of the low recoveries, so the true measure of accuracy is not known and the sample concentrations may be underrepresented. Dilution was required because of matrix problems, so the detection limits are high. Action levels are significantly higher than the detection limits, so even though the sample concentrations may be underrepresented, it is unlikely that sulfide is present at levels of concern.

Ground Water

Explosives

MS/MSD data are provided for explosives in Table B-10. The MS/MSD recoveries were acceptable for RDX and TNT. The MSD was just outside the control limits for DNT but should have only minimal impact on the data. All RPDs were acceptable. MS/MSD recoveries of HMX for the primary column were inflated, but the confirmation column recoveries were acceptable, so results from the confirmation column only were reported for HMX. Explosives data in general appears to be valid and of acceptable quality.

VOCs

Detection limits achieved for VOCs in ground water are shown in Table B-3. These limits represent the concentration at which a compound can be positively identified with confidence. The level of uncertainty associated with quantitation between one and five times the detection limit is greater than that for values above five times the detection limit.

Matrix spike/matrix spike duplicate data are provided for VOCs in Table B-11. All results recoveries were within the control limits, and only one RPD was outside the limits. The benzene RPD was just slightly outside the control limits, and the compound was not even detected in the sample, so the impact to the data is minimal. Thus, the VOC data are considered to be of high quality, with good precision and accuracy.

SVOCs

Detection limits achieved for SVOCs in ground water are shown in Table B-4. These limits represent the lowest concentration at which a compound can be positively identified with confidence. The level of uncertainty associated with quantitation between one and five times the detection limit is greater than that for values above five times the detection limit.

Matrix spike/matrix spike duplicate data are provided for SVOCs in Table B-12. All results (both recoveries and RPDs) were within the control limits, so the SVOC data are considered to be of high quality, with good precision and accuracy.

Metals

As shown in Table B-13, all MS/MSD recoveries were acceptable, except for lead and mercury. Only the MSD was outside the control limits for mercury, by a very small, insignificant margin. The lead results reported are for analysis by atomic absorption (AA) and are very erratic. The recoveries for lead analyzed by ICP (Method 6010) were much improved and more appropriate for the concentration present, but the exact recovery values are not available.

General Chemistry

The QC results for the general inorganic chemistry parameters were somewhat inconsistent, as shown in Table B-14. The MS/MSD recoveries for cyanide were acceptable. The RPD was slightly high, but good enough for assessment of the level of contaminants found.

The QC (MS/MSD recoveries and RPDs) results for nitrate in groundwater were acceptable, as were the QC results for sulfide. Although the soil QC proved inconclusive for sulfide, in water the QC results showed definitively that no contamination was present at levels above the detection limit.

Table B-1
Detection Limits for Volatile Organics - Soil Analysis

Compound	Detection Limit ($\mu g/kg$)
Chloromethane	10-12
Bromomethane	10-12
Vinyl chloride	10-12
Chloroethane	10-12
Methylene chloride	5-6
Acetone	10-12
Carbon disulfide	5-6
1,1-Dichloroethene	5-6
1,1-Dichloroethane	5-6
1,2-Dichloroethene (total)	5-6
Chloroform	5-6
1,2-Dichloroethane	5-6
2-Butanone	10-12
1,1,1-Trichloroethane	5-6
Carbon tetrachloride	5-6
Vinyl acetate	10-12
Bromodichloromethane	5-6
1,2-Dichloropropane	5-6
cis-1,3-Dichloropropene	5-6
Trichloroethene	5-6
Dibromochloromethane	5-6
1,1,2-Trichloroethane	5-6
Benzene	5-6
Trans-1,3-dichloropropene	5-6
Bromoform	5-6
2-Methyl-2-pentanone	10-12
2-Hexanone	10-12
Tetrachloroethene	5-6
1,1,2,2-Tetrachloroethane	5-6

Table B-1
(Continued)

Compound	Detection Limit ($\mu g/kg$)
Toluene	5-6
Chlorobenzene	5-6
Ethylbenzene	5-6
Styrene	5-6
Total xylenes	5-6
Methacrylonitrile	5-6
Trichlorofluoromethane	5-6
Methyl iodide	5-6
3-Chloropropene (Allyl Chlor.)	100-120
Dibromomethane	5-6
Chloroprene	5-6
1,1,1,2-Tetrachloroethane	5-6
1,2,3-Trichloropropane	5-6
trans-1,4-Dichloro-2-butene	5-6
Ethyl methacrylate	5-6
Pentachloroethane	5-6
1,2-Dibromo-3-chloropropane	5-6
Dichlorodifluoromethane	50-61
Methyl methacrylate	5-6
Acetonitrile	100-120
Propionitrile	5-6

Table B-2
Detection Limits for Semivolatile Organics - Soil Analysis

Compound	Detection Limit ($\mu g/kg$)
Phenol	350-490
bis(2-Chloroethyl)ether	350-490
2-Chlorophenol	350-490
1,3-Dichlorobenzene	350-490
1,4-Dichlorobenzene	350-490
Benzyl alcohol	350-490
1,2-Dichlorobenzene	350-490
2-Methylphenol	350-490
bis(2-chloroisopropyl)ether	350-490
3- & 4-Methylphenol	350-490
N-Nitroso-di-n-propylamine	350-490
Hexachloroethane	350-490
Nitrobenzene	350-490
Isophorone	350-490
2-Nitrophenol	350-490
2,4-Dimethylphenol	350-490
Benzoic Acid	1,700-2,400
bis(2-Chloroethoxy)methane	350-490
2,4-Dichlorophenol	350-490
1,2,4-Trichlorobenzene	350-490
Naphthalene	350-490
4-Chloroaniline	350-490
Hexachlorobutadiene	350-490
4-Chloro-3-methylphenol	350-490
2-Methylnaphthalene	350-490
Hexachlorocyclopentadiene	350-490
2,4,6-Trichlorophenol	350-490
2,4,5-Trichlorophenol	350-490
2-Chloronaphthalene	350-490

Table B-2
(Continued)

Compound	Detection Limit (μg/kg)
2-Nitroaniline	1,700-2,400
Dimethylphthalate	350-490
Acenaphthylene	350-490
2,6-Dinitrotoluene	350-490
3-Nitroaniline	1,700-2,400
Acenaphthene	350-490
2,4-Dinitrophenol	1,700-2,400
4-Nitrophenol	1,700-2,400
Dibenzofuran	350-490
2,4-Dinitrotoluene	350-490
Diethylphthalate	350-490
4-Chlorophenyl-phenylether	350-490
Fluorene	350-490
4-Nitroaniline	1,700-2,400
4,6-Dinitro-2-methylphenol	1,700-2,400
N-nitrosodiphenylamine[a]	350-490
4-Bromophenyl-phenylether	350-490
Hexachlorobenzene	350-490
Pentachlorophenol	1,700-2,400
Phenanthrene	350-490
Anthracene	350-490
Di-n-butylphthalate	350-490
Fluoranthene	350-490
Pyrene	350-490
Butylbenzylphthalate	350-490
3,3'-Dichlorobenzidine	690-980
Benzo(a)anthracene	350-490
Chrysene	350-490

Table B-2
(Continued)

Compound	Detection Limit (μg/kg)
bis(2-Ethylhexyl)phthalate	350-490
Di-n-octyl phthalate	350-490
Benzo(b)fluoranthene	350-490
Benzo(k)fluoranthene	350-490
Benzo(a)pyrene	350-490
Indeno(1,2,3-cd)pyrene	350-490
Dibenz(a,h)anthracene	350-490
Benzo(g,h,i)perylene	350-490
Pyridine	690-980
N-nitrosodimethylamine	350-490
Aniline	350-490
Acetophenone	350-490
2-Acetylaminofluorene	350-490
4-Aminobiphenyl	350-490
Aramite (total)	3,500-4,900
Dinoseb	1,700-2,500
Chlorobenzilate	350-490
2,6-Dichlorophenol	350-490
p-Dimethylaminoazobenzene	350-490
3,3′-Dimethylbenzidine	350-490
Hexachloropropene	1,700-2,500
Isosafrole	1,700-2,500
Methapyrilene	350-490
3-Methylcholanthrene	350-490
Methylmethanesulfonate	350-490
1,4-Naphthoquinone	350-490
1-Naphthylamine	350-490
2-Naphthylamine	350-490

Table B-2
(Continued)

Compound	Detection Limit (μg/kg)
N-Nitrosodi-n-butylamine	350-490
N-Nitrosodiethylamine	350-490
N-Nitrosomethylethylamine	350-490
N-Nitrosomorpholine	350-490
N-Nitrosopiperidine	350-490
N-Nitrosopyrrolidine	350-490
5-Nitro-o-toluidine	350-490
Pentachlorobenzene	350-490
Pentachloronitrobenzene	1,700-2,500
Phenancetin	350-490
Pronamide	350-490
Safrole	1,700-2,500
1,2,4,5-Tetrachlorobenzene	350-490
2,3,4,6-Tetrachlorophenol	350-490
p-Phenylenediamine	350-490
2-Picoline	350-490
a,a-dimethylphenethylamine	350-490
m-dinitrobenzene	1,700-2,500
ethyl methanesulfonate	350-490
4-nitroquinoline-1-oxide	3,500-4,900
7,12-Dimethylbenz(a)anthracene	350-490
o-Toluidine	350-490
sym-Trinitrobenzene	350-490

[a] Cannot be separated from Diphenylamine.

Table B-3
Detection Limits for Volatile Organics - Ground-water Analysis

Compound	Detection Limit ($\mu g/L$)
Chloromethane	10
Bromomethane	10
Vinyl chloride	10
Chloroethane	10
Methylene chloride	5
Acetone	10
Carbon disulfide	5
1,1-Dichloroethene	5
1,1-Dichloroethane	5
1,2-Dichloroethene (total)	5
Chloroform	5
1,2-Dichloroethane	5
2-Butanone	10
1,1,1-Trichloroethane	5
Carbon tetrachloride	5
Vinyl acetate	10
Bromodichloromethane	5
1,2-Dichloropropane	5
cis-1,3-Dichloropropene	5
Trichloroethene	5
Dibromochloromethane	5
1,1,2-Trichloroethane	5
Benzene	5
Trans-1,3-dichloropropene	5
Bromoform	5
2-Methyl-2-pentanone	10
2-Hexanone	10
Tetrachloroethene	5
1,1,2,2-Tetrachloroethane	5

Table B-3
(Continued)

Compound	Detection Limit ($\mu g/L$)
Toluene	5
Chlorobenzene	5
Ethylbenzene	5
Styrene	5
Total xylenes	5
Acetonitrile	100
Acrolein	100
Acrylonitrile	100
N-butyl alcohol	4,000
2-Chloro-1,3-butadiene	100
3-Chloropropene	100
1,2-Dibromo-3-chloropropane	10
1,2-Dibromoethane	5
Dibromomethane	5
trans-1,4-Dichloro-2-butene	100
Dichlorodifluoromethane	10
1,4-Dioxane	400
Total monochlorotoluene	5
Ethyl acetate	5
Ethyl cyanide	100
Diethylether	100
Ethyl methacrylate	100
Iodomethane	50
Pentachloroethane	5
Methyl methacrylate	100
Methacrylonitrile	100
2-Nitropropane	100
1,1,1,2-Tetrachloroethane	5

Table B-3
(Continued)

Compound	Detection Limit (µg/L)
1,2,3-Trichloropropane	5
Trichlorotrifluoroethane	5
Trichlorofluoromethane	5
2-Chloroethylvinylether	10

Table B-4
Detection Limits for Semivolatile Organics - Ground-water Analysis

Compound	Detection Limit ($\mu g/L$)
Phenol	10-12
bis(2-Chloroethyl)ether	10-12
2-Chlorophenol	10-12
1,3-Dichlorobenzene	10-12
1,4-Dichlorobenzene	10-12
Benzyl alcohol	10-12
1,2-Dichlorobenzene	10-12
2-Methylphenol	10-12
bis(2-chloroisopropyl)ether	10-12
3- & 4-Methylphenol	10-12
N-Nitroso-di-n-propylamine	10-12
Hexachloroethane	10-12
Nitrobenzene	10-12
Isophorone	10-12
2-Nitrophenol	10-12
2,4-Dimethylphenol	10-12
Benzoic Acid	52-59
bis(2-Chloroethoxy)methane	10-12
2,4-Dichlorophenol	10-12
1,2,4-Trichlorobenzene	10-12
Naphthalene	10-12
4-Chloroaniline	10-12
Hexachlorobutadiene	10-12
4-Chloro-3-methylphenol	10-12
2-Methylnaphthalene	10-12
Hexachlorocyclopentadiene	10-12
2,4,6-Trichlorophenol	10-12
2,4,5-Trichlorophenol	10-12
2-Chloronaphthalene	10-12

Table B-4
(Continued)

Compound	Detection Limit ($\mu g/L$)
2-Nitroaniline	52-59
Dimethylphthalate	10-12
Acenaphthylene	10-12
2,6-Dinitrotoluene	10-12
3-Nitroaniline	52-59
Acenaphthene	10-12
2,4-Dinitrophenol	52-59
4-Nitrophenol	52-59
Dibenzofuran	10-12
2,4-Dinitrotoluene	10-12
Diethylphthalate	10-12
4-Chlorophenyl-phenylether	10-12
Fluorene	10-12
4-Nitroaniline	52-59
4,6-Dinitro-2-methylphenol	52-59
N-nitrosodiphenylamine[a]	10-12
4-Bromophenyl-phenylether	10-12
Hexachlorobenzene	10-12
Pentachlorophenol	52-59
Phenanthrene	10-12
Anthracene	10-12
Di-n-butylphthalate	10-12
Fluoranthene	10-12
Pyrene	10-12
Butylbenzylphthalate	10-12
3,3'-Dichlorobenzidine	21-24
Benzo(a)anthracene	10-12
Chrysene	10-12

Table B-4
(Continued)

Compound	Detection Limit ($\mu g/L$)
bis(2-Ethylhexyl)phthalate	10-12
Di-n-octyl phthalate	10-12
Benzo(b)fluoranthene	10-12
Benzo(k)fluoranthene	10-12
Benzo(a)pyrene	10-12
Indeno(1,2,3-cd)pyrene	10-12
Dibenz(a,h)anthracene	10-12
Benzo(g,h,i)perylene	10-12
Pyridine	21-24
N-nitrosodimethylamine	10-12
Aniline	10-12
Acetophenone	10-12
2-Acetylaminofluorene	10-12
4-Aminobiphenyl	10-12
Aramite (total)	100-120
Dinoseb	52-59
Chlorobenzilate	10-12
2,6-Dichlorophenol	10-12
p-Dimethylaminoazobenzene	10-12
3,3′-Dimethylbenzidine	10-12
Hexachloropropene	52-59
Isosafrole	52-59
Methapyrilene	10-12
3-Methylcholanthrene	10-12
Methylmethanesulfonate	10-12
1,4-Naphthoquinone	10-12
1-Naphthylamine	10-12
2-Naphthylamine	10-12

Table B-4
(Continued)

Compound	Detection Limit ($\mu g/L$)
N-Nitrosodi-n-butylamine	10-12
N-Nitrosodiethylamine	10-12
N-Nitrosomethylethylamine	10-12
N-Nitrosomorpholine	10-12
N-Nitrosopiperidine	10-12
N-Nitrosopyrrolidine	10-12
5-Nitro-o-toluidine	10-12
Pentachlorobenzene	10-12
Pentachloronitrobenzene	52-59
Phenancetin	10-12
Pronamide	10-12
Safrole	52-59
1,2,4,5-Tetrachlorobenzene	10-12
2,3,4,6-Tetrachlorophenol	10-12
p-Phenylenediamine	10-12
2-Picoline	10-12
a,a-dimethylphenethylamine	10-12
m-dinitrobenzene	52-59
ethyl methanesulfonate	10-12
4-nitroquinoline-1-oxide	100-120
7,12-Dimethylbenz(a)anthracene	10-12
o-Toluidine	10-12
sym-Trinitrobenzene	10-12

[a] Cannot be separated from Diphenylamine.

Table B-5
Matrix Spike/Matrix Spike Duplicate Recoveries for Volatile Organics in Soil
(Sample 6)

Compound	Matrix Spike (% Recovery)	Matrix Spike Duplicate (% Recovery)	RPD (%)	QC Limits	
				RPD	Recovery
1,1-Dichloroethene	93	89	4	0-22	59-172
Trichloroethene	83	83	0	0-24	62-137
Benzene	91	88	3	0-21	66-142
Toluene	95	90	5	0-21	59-139
Chlorobenzene	88	87	1	0-21	60-133

Table B-6
Matrix Spike/Matrix Spike Duplicate Recoveries for Semivolatile Organics in Soil
(Sample 6)

Compound	Matrix Spike (% Recovery)	Matrix Spike Duplicate (% Recovery)	RPD (%)	QC Limits	
				RPD	Recovery
Phenol	51	58	13	0-35	26-90
2-Chlorophenol	53	60	12	0-50	25-102
1,4-Dichlorobenzene	51	59	15	0-27	28-104
N-Nitroso-di-n-propylamine	70	77	10	0-38	41-126
1,2,4-Trichlorobenzene	59	66	11	0-23	38-107
4-Chloro-3-methylphenol	38	49	25	0-33	26-103
Acenaphthene	79	84	6	0-19	31-137
4-Nitrophenol	77	79	3	0-50	11-114
2,4-Dinitrotoluene	86	88	2	0-47	28-89
Pentachlorophenol	74	81	9	0-47	17-109
Pyrene	88	94	7	0-36	35-142

Table B-7
Matrix Spike/Matrix Spike Duplicate Recoveries for Metals in Soil
(Sample 6)

Metal	Matrix Spike (% Recovery)	Matrix Spike Duplicate (% Recovery)	% RPD	QC Limits	
				RPD	Recovery
Aluminum	30	29	0.2	0-20	75-125
Antimony	58	59	2.5	0-20	75-125
Arsenic	59	84	22	0-20	75-125
Barium	100	90	7.5	0-20	75-125
Beryllium	85	83	1.6	0-20	75-125
Cadmium	81	79	1.1	0-20	75-125
Calcium	82	78	3.2	0-20	75-125
Chromium	67	66	0.2	0-20	75-125
Cobalt	86	84	1.0	0-20	75-125
Copper	83	80	2.9	0-20	75-125
Iron	-94	-13	9.9	0-20	75-125
Lead	-75	-92	13	0-20	75-125
Magnesium	79	76	3.0	0-20	75-125
Manganese	91	78	8.4	0-20	75-125
Mercury	162	152	4.0	0-20	75-125
Nickel	69	68	0.7	0-20	75-125
Potassium	85	88	4.0	0-20	75-125
Selenium	68	76	12	0-20	75-125
Silver	80	78	1.8	0-20	75-125
Sodium	88	84	3.6	0-20	75-125
Thallium	109	109	0.9	0-20	75-125
Vanadium	82	81	0.4	0-20	75-125
Zinc	82	76	4.5	0-20	75-125
Tin	78	77	0.6	0-20	75-125

Table B-8
Matrix Spike Recoveries and Duplicate Results for TCLP Metals
(Sample 6)

Metal	Matrix Spike (% Recovery)	Sample Concentration (μg/L)	Duplicate Concentration (μg/L)	% RPD	QC Limits	
					RPD	Recovery
Arsenic	99.8	ND (210)	ND (210)	NC	0-20	75-125
Barium	90.0	765	755	1.4	0-20	75-125
Cadmium	95.1	ND (30.0)	ND (30.0)	NC	0-20	75-125
Chromium	97.6	ND (20.0)	ND (20.0)	NC	0-20	75-125
Lead	98.9	3,060	3,050	0.6	0-20	75-125
Mercury	90.8	ND (5.0)	ND (5.0)	NC	0-20	75-125
Selenium	102	ND (10.0)	ND (10.0)	NC	0-20	75-125
Silver	72.8	ND (40.0)	ND (40.0)	NC	0-20	75-125

NC = Not calculable.

Table B-9
Quality Control Results for General Chemistry Parameters - Soil Analysis
(Sample 6)

Analyte/Parameter	Matrix Spike (% Recovery)	Matrix Spike Duplicate (% Recovery)	RPD (%)	Lab Dupl. RPD (%)	Field Dupl. RPD (%)
Cyanide	157	169	2.5	92	63
NO_3-N	52	80	22.4	5.1	103
Sulfide	0[a]	0[a]	NC	NC	NC

ND = Not calculated.

[a] Spiked and unspiked samples have concentrations below the detection limit even though the spike added was above the detection limit. The low recovery is attributable to matrix interference.

Table B-10
Matrix Spike/Matrix Spike Duplicate Recoveries for Explosives in Ground Water
(W1 Sample)

Compound	Matrix Spike (% Recovery)	Matrix Spike Duplicate (% Recovery)	RPD (%)
HMX[a]	112	96	15
RDX	92	78	16
TNT	85	79	7
DNT[b]	71	61	15

[a] Results from the confirmation column are reported because recoveries from the primary column were inflated.

[b] 2,4-DNT and 2,6-DNT are reported together.

Table B-11
Matrix Spike/Matrix Spike Duplicate Recoveries for Volatile Organics in Ground Water
(W1 Sample)

Compound	Matrix Spike (% Recovery)	Matrix Spike Duplicate (% Recovery)	RPD (%)	QC Limits	
				RPD	Recovery
1,1-Dichloroethene	77	84	9	0-14	61-145
Trichloroethene	94	108	14	0-14	71-120
Benzene	94	108	14[a]	0-11	76-127
Toluene	107	120	11	0-13	76-125
Chlorobenzene	104	119	13	0-13	75-130

[a] The RPD for this analyte was outside the QC limits.

Table B-12
Matrix Spike/Matrix Spike Duplicate Recoveries for Semivolatile Organics in Ground Water
(W1 Sample)

Compound	Matrix Spike (% Recovery)	Matrix Spike Duplicate (% Recovery)	RPD (%)	QC Limits	
				RPD	Recovery
Phenol	60	59	2	0-42	12-89
2-Chlorophenol	59	59	0	0-40	27-123
1,4-Dichlorobenzene	63	65	3	0-28	36-97
N-Nitroso-di-n-propylamine	71	71	0	0-38	41-116
1,2,4-Trichlorobenzene	62	63	2	0-28	39-98
4-Chloro-3-methylphenol	71	70	1	0-42	23-97
Acenaphthene	60	55	5	0-31	46-118
4-Nitrophenol	78	74	8	0-50	10-80
2,4-Dinitrotoluene	61	66	6	0-38	24-96
Pentachlorophenol	72	68	2	0-50	9-103
Pyrene	55	56	9	0-31	26-127

Table B-13
Matrix Spike/Matrix Spike Duplicate Recoveries for Metals in Ground Water
(W1 Sample)

Metal	Matrix Spike (% Recovery)	Matrix Spike Duplicate (% Recovery)	% RPD	QC Limits	
				RPD	Recovery
Aluminum	92	117	9.7	0-20	75-125
Antimony	76	72	4.9	0-20	75-125
Arsenic	75	98	19	0-20	75-125
Barium	110	100	6.3	0-20	75-125
Beryllium	100	89	11	0-20	75-125
Cadmium	96	84	12	0-20	75-125
Calcium	92	90	1.2	0-20	75-125
Chromium	96	96	0.3	0-20	75-125
Cobalt	100	90	11	0-20	75-125
Copper	104	94	9.3	0-20	75-125
Iron	90	118	6.6	0-20	75-125
Lead	278	-278	11	0-20	75-125
Magnesium	96	98	0.9	0-20	75-125
Manganese	110	98	8.1	0-20	75-125
Mercury	107	138	9.2	0-20	75-125
Nickel	97	86	12	0-20	75-125
Potassium	99	106	4.9	0-20	75-125
Selenium	94	101	6.9	0-20	75-125
Silver	100	87	14	0-20	75-125
Sodium	98	91	2.5	0-20	75-125
Thallium	87	82	6.0	0-20	75-125
Vanadium	101	91	9.8	0-20	75-125
Zinc	99	99	0.1	0-20	75-125
Tin	89	89	0.0	0-20	75-125

Table B-14
Quality Control Results for General Chemistry Parameters - Ground-water Analysis
(W1 Sample)

Analyte/Parameter	Matrix Spike (% Recovery)	Matrix Spike Duplicate (% Recovery)	RPD (%)
Cyanide	119	80	39
NO_3-N	112	110	1.8
Sulfide	109	101	7.6